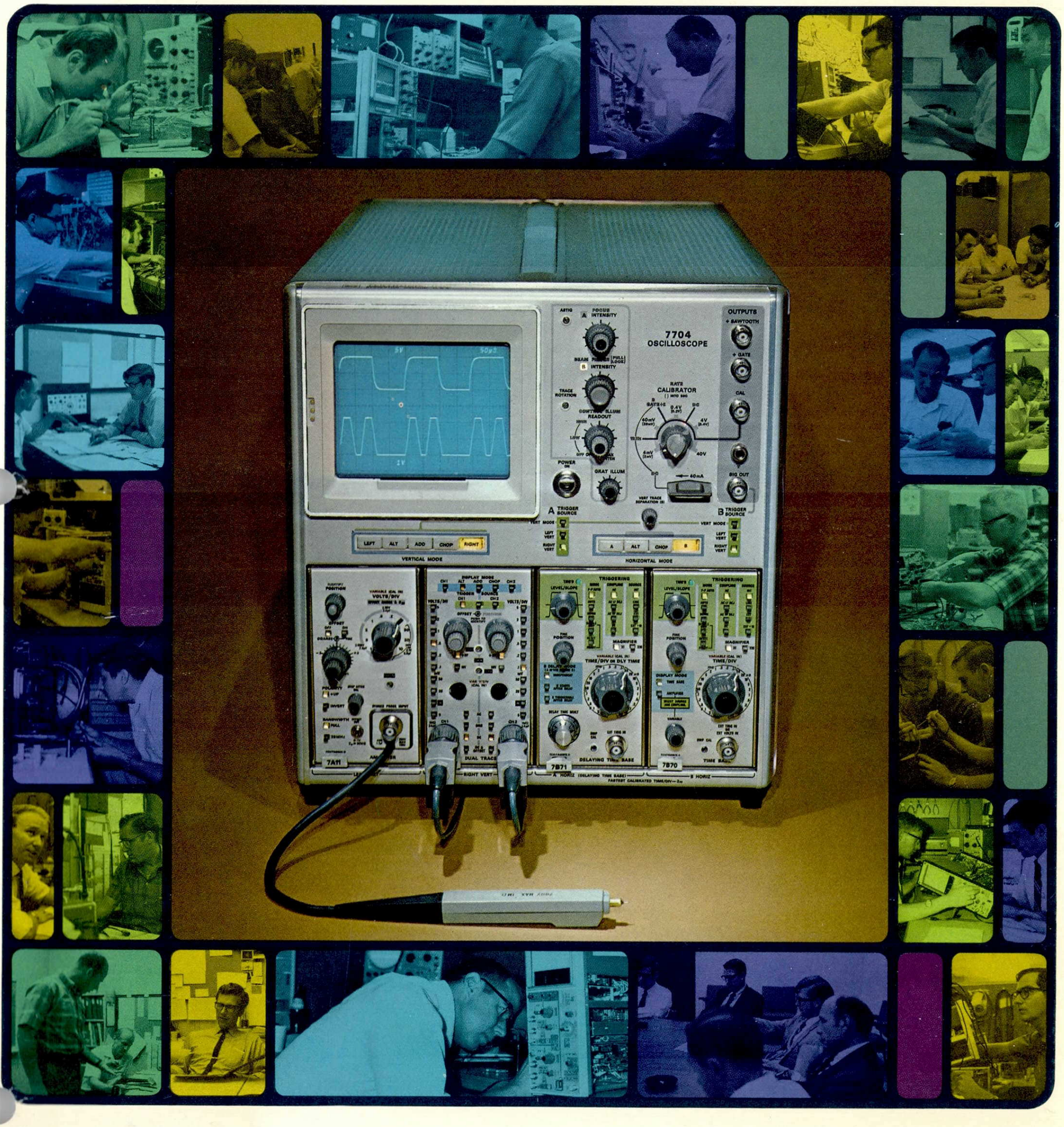
TEKTRONIX®

OSCILLOSCOPES & ASSOCIATED INSTRUMENTS



committed to progress in waveform measurement

How to Use This Catalog

Tektronix products are indexed in alphanumeric order according to type numbers and by functional use on the last 4 pages of this catalog. For those not familiar with the identifying alphanumeric symbol for each instrument, the products are grouped according to common characteristics on page 1. Each division of products has a contents section and reference information to allow comparison of performance of a group of instruments with your measurement requirements. For example, television instruments; spectrum analyzers; those oscilloscopes that feature portability; those that use the same group of plug-in units etc. A study of the reference information for each group will give you a better understanding of the Tektronix product line.

To use the product listing as found on page 1, notice that a colored tab is placed on the right edge of the page. There is another tab of the same color in the same position on a page within the body of the catalog, this tab is located on the 1st page of the instrument group. By holding the book in a position that allows the edges of the pages to fan out, both tabs become obvious and turning to the first page of that section is easy.

FIELD OFFICE ASSISTANCE

Tektronix maintains 71 domestic and international field offices as well as 50 distributors and representatives throughout the world. These offices are staffed with qualified field engineers who specialize in solving measurement problems. They provide a direct communication link between you and the factory and are the people to contact for assistance. Please call or visit your nearest field office for details on applications, maintenance, instrument selection or instrument orders. You'll find these offices listed on pages 6 through 10.

Ordering information such as terms, shipment, and warranty details are contained on pages 6 through 10.

INSTRUMENT DIMENSIONS

Charts of dimensions of rackmounted instruments and shipping volume of all instruments are listed on pages 11 and 12.

ELECTRICAL and MECHANICAL CONSIDERATIONS

Information about ventilation, power requirements, and construction is found on page 13.

PUBLICATIONS AVAILABLE

Pages 14 and 15 contain a list of technical publications available through your Tektronix Field Engineer.

SYMBOLS & ABBREVIATIONS

A table of symbols and abbreviations as used in this catalog is presented on page 13.

GENERAL TERMS OF SALE

Tektronix offers many different terms of sale in order to meet varied purchasing objectives and to assist in financial planning. A summary of those terms is listed below. Please turn to page 6 for complete details.

NET 30 DAYS

Tektronix standard terms of sale are NET 30 days, which is to agree that payment will be deferred for thirty days following shipment.

LEASE AGREEMENT

All new instruments, digital systems, computer terminals, cameras, Scope-Mobile® Carts and modifications thereof are available under this program that provides monthly installment payment terms while Tektronix products are in use. Under a LEASE AGREEMENT, the customer pays for the USE of the product for the term of agreement. It is not a month-to-month rental . . . it is a non-cancellable, fixed-term lease requiring **no advance payment whatsoever.** The customer also has an option to purchase the leased equipment.

EXTENDED TERMS OF SALE

Extended terms of 60 to 120 days are available on the same single payment basis as standard terms. Since the cost of extended terms is not included in catalog prices, a service charge is added to the product invoice.

CONDITIONAL SALES CONTRACT

This program provides monthly installment payment terms while Tektronix products are in use. All instruments, digital systems, cameras, Scope-Mobile® Carts and modifications thereof are available. An advance payment equal to approximately 10% of the purchase price of the equipment desired is required for a CONDITIONAL SALES CONTRACT. Upon completion of the term of agreement and prescribed payments, the customer owns the equipment.

Tektronix, Inc.
An Oregon Corporation

MAILING ADDRESS:
P.O. BOX 500, BEAVERTON, OREGON 97005

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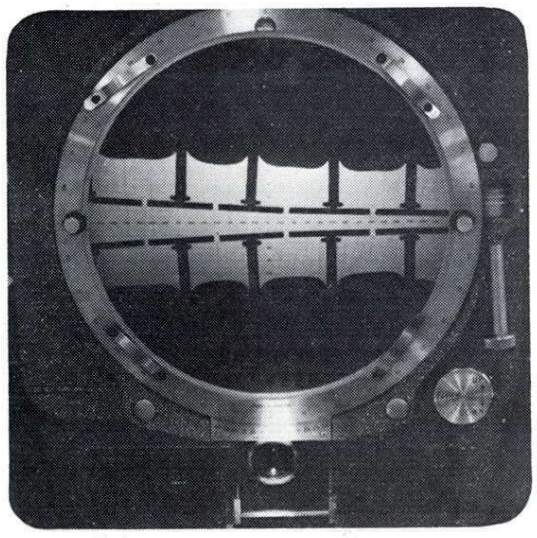
THIS IS TEKTRONIX . . . . .

Photo by Josef Oswald

Pictured is the Tektronix Industrial Park located in Beaverton, Oregon. This is how we look today; we didn't look like this last year, and it's not how we'll look next year. Building expansion is perpetual as sales continue to increase, and an ever expanding product line requires specialized facilities. Other manufacturing facilities are located at Heerenveen, The Netherlands; Guernsey, Channel Islands; and Tokyo, Japan.

The assembly of components into a finished product is but one of the functions of this complex. Much of what goes into an instrument bearing the name Tektronix is designed and manufactured here also. Exacting standards of component manufacture is part of our commitment to technical excellence; some of those components are described below and on page 3.

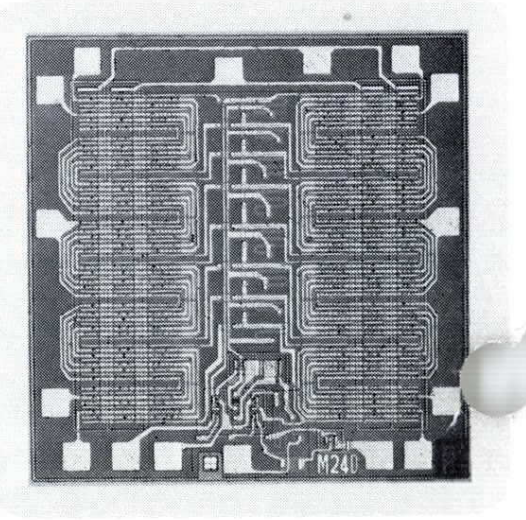


CATHODE-RAY TUBES

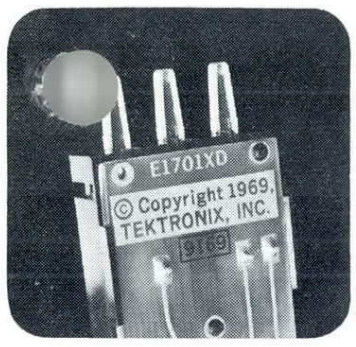
At Tektronix, the cathode-ray tube is considered to be the heart of each oscilloscope. Each instrument has a cathode-ray tube designed to optimize total performance. The electron optics developed for the Type 454 CRT feature distributed vertical deflection plates (shown) that contribute significantly to the performance of the Type 454 Oscilloscope.

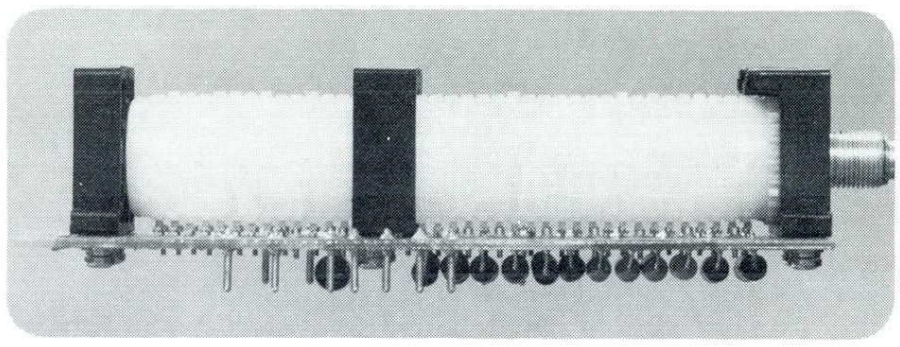
INTEGRATED CIRCUITS

The ability to custom-design integrated circuits permits instrument features that would otherwise be prohibitively expensive. A character-generator IC with 1440 emitters made it possible to provide the new 7000 Series Oscilloscopes with automatic scale-factor readout.



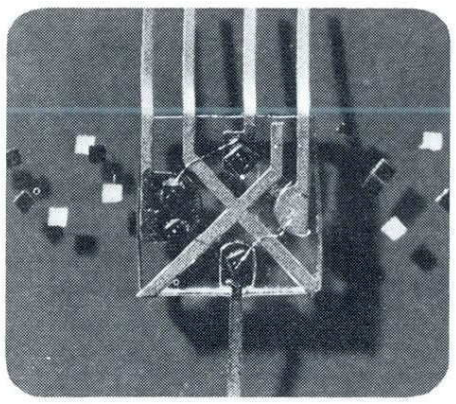
Some Factors Affecting the Value of Tektronix Products





SWITCHES

Our switch engineering capability contributed significantly to the human engineering of the new 5000 and 7000 Series Oscilloscopes. Miniature lighted push buttons and the replacement of bulky multi-ganged rotary switches by small reliable rotary cam switches simplfy the front panel logic and conserve space.

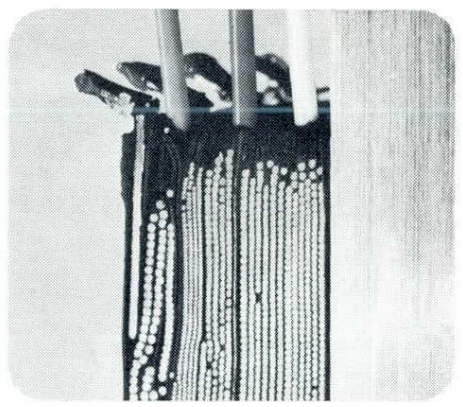


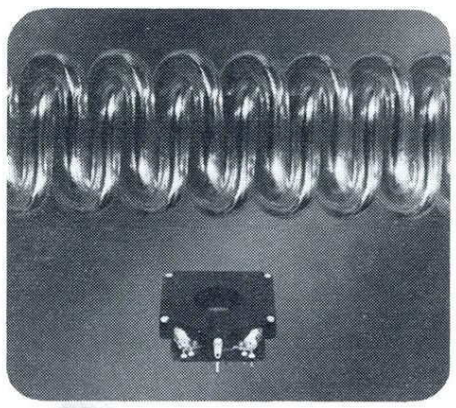
SEMICONDUCTORS

Tektronix designs and manufactures semiconductors to satisfy specialized instrument requirements. Notable examples are semiconductors used in sampling oscilloscopes that feature state-of-the-art measurements.

POWER TRANSFORMERS

Designing and manufacturing our own transformers permits our engineers to easily satisfy the power supply requirements of each instrument. Power transformers, designed and manufactured at Tektronix, are warranted for the life of the instrument.



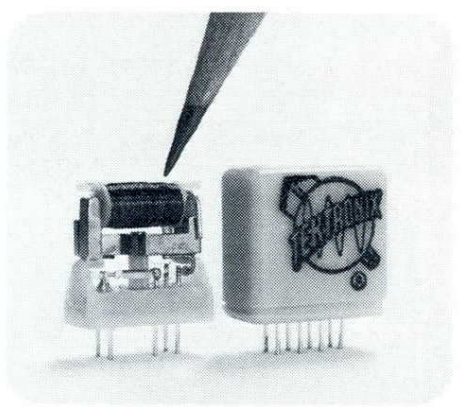


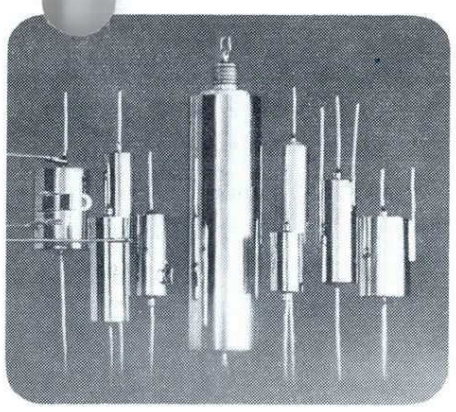
CABLES

Cable technology permits us to make compact delay lines and voltage and current probes that are a necessary requirement for high-performance oscilloscopes. We manufacture more than 2,000,000 feet of probe cables and delay lines each year. The illustrated over-and-under winding technique provides increased pulse delay and preserves waveform fidelity.

RELAYS

Tektronix designed miniature relays plug into a socket assuring quick and easy servicing. They are used extensively in the new 5000 and 7000 Series Oscilloscopes.



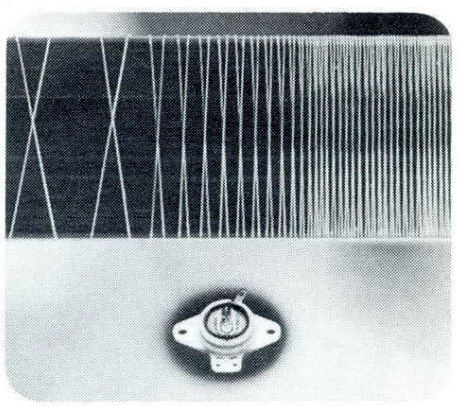


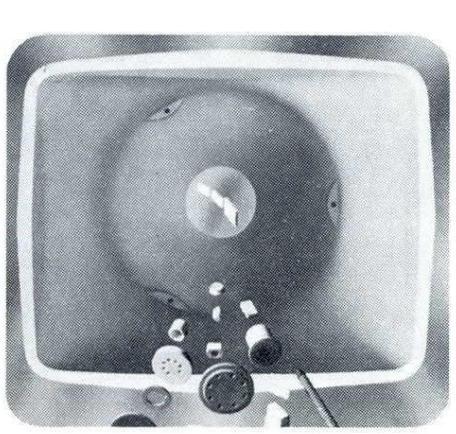
CAPACITORS

Building our own capacitors permits us to meet specific performance requirements and make special sizes and mounting configurations. Timing capacitors and input-coupling capacitors are critical components in oscilloscope performance.

RESISTORS

Variable resistors, with reverse and multiple pitched windings, provide a controlled inductance per unit resistance. Used as variable controls in Tektronix oscilloscopes, they change the vertical gain of the oscilloscope while maintaining pulse fidelity.



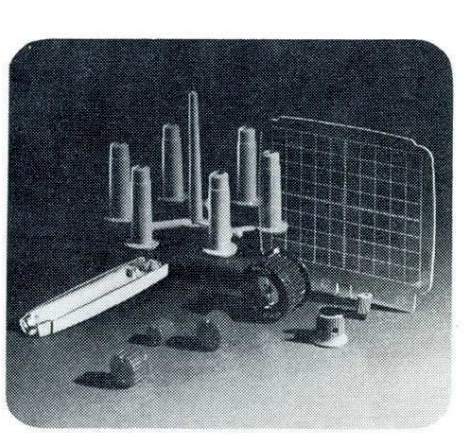


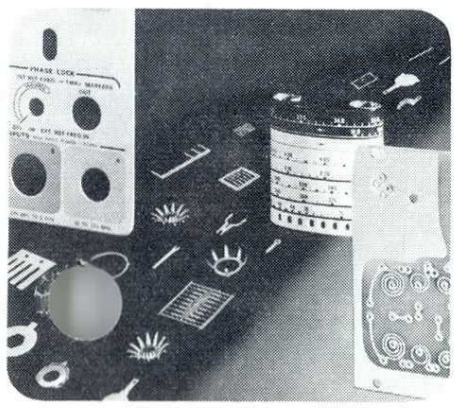
CERAMICS

Our ceramic technology gives us the ability to produce ceramic CRT's with increased strength, tight internal tolerances, and improved edge lighting for the illuminated internal graticules. We also produce a wide variety of specialized ceramic parts designed to satisfy specific oscilloscope requirements.

PLASTICS

Plastics technology provides Tektronix with many components. Voltage and current probe parts made with special plastics reduce undesirable electrical effects and withstand rugged use. Other plastic parts include special switch couplings, handles, knobs, capacitor mounts and covers, and many other items designed to optimize oscilloscope performance.





METALS

Our metals technology and production capability provide design freedom for our engineers. Fabrication of any and all metal parts, from the precision machining required for spectrum analyzers to forming chassis of oscilloscopes, gives Tektronix a valuable tool in the design of new products.

ELECTROCHEMICAL

Precision electroplating of plastics and other materials, and electroforming intricately shaped parts are daily tasks of our electrochemical department. Chemical machining can quickly produce prototype parts for evaluation by design engineers while maintaining critical tolerances.

Tektronix Field Services

There are many field services available through Tektronix Field Engineering Offices and Overseas Representatives, as it is our aim to provide the kind of service that you expect. Some of these services are described below. Why not take advantage of them?

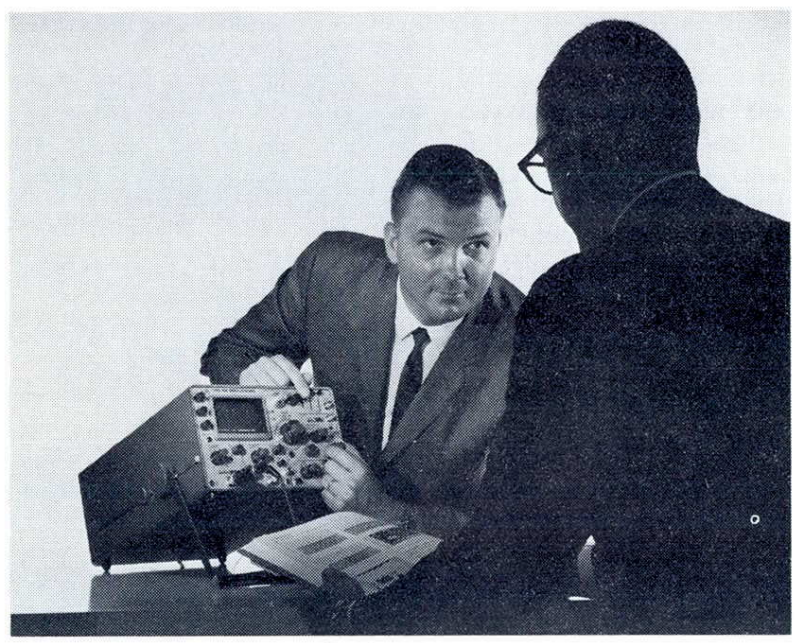
FIELD ENGINEERS

Your Field Engineer has a strong technical background and has received several months of product training at the factory; periodic refresher courses fully acquaint him with new products. Be sure to take advantage of his services.

ORDERING

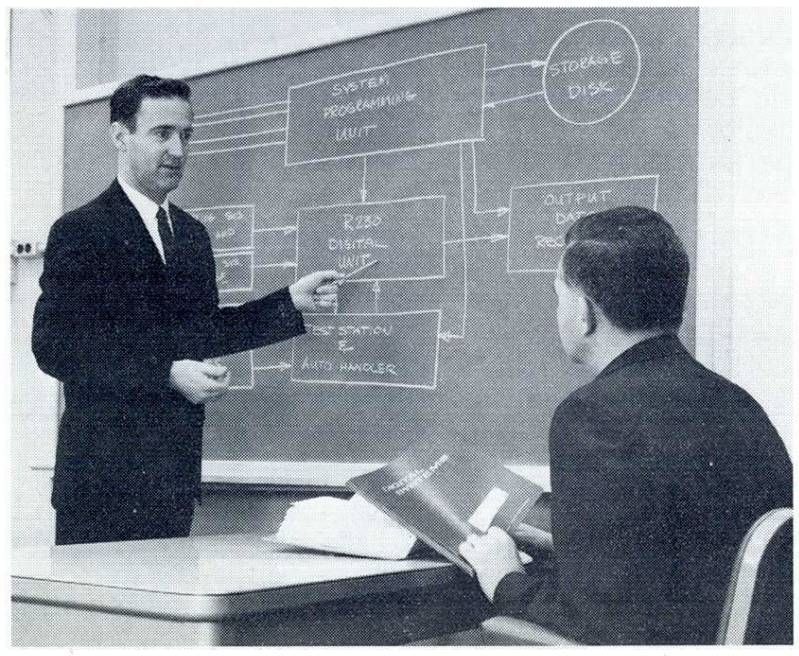
There are many types of oscilloscopes, each designed for a specific application area. Your Field Engineer can help you select the one best suited to your present and future needs, and he will be happy to arrange a demonstration of the instrument . . . in your application if you so desire.

If you are a Purchasing Agent or Buyer, your Field Engineer *or his secretary* can provide information on prices, terms, shipping estimates, and best method of transportation on instruments, accessories, and replacement parts.



OPERATION

Your Tektronix Oscilloscope can be most useful to you when you are familiar with all control functions. Your Field Engineer will be glad to demonstrate the use of your instrument in various applications to help you become more familiar with its operation. If your instrument is to be used by several engineers, your Field Engineer will be happy to conduct informal classes on its operation in your laboratory.



APPLICATIONS

Perhaps the answers you need in a specific application can be obtained faster and easier through use of your Tektronix Oscilloscope. Your Field Engineer can help you find out, and if use of your oscilloscope is indicated, help you with procedures. He may also be able to suggest many time-saving uses for your oscilloscope in routine checks and measurements.

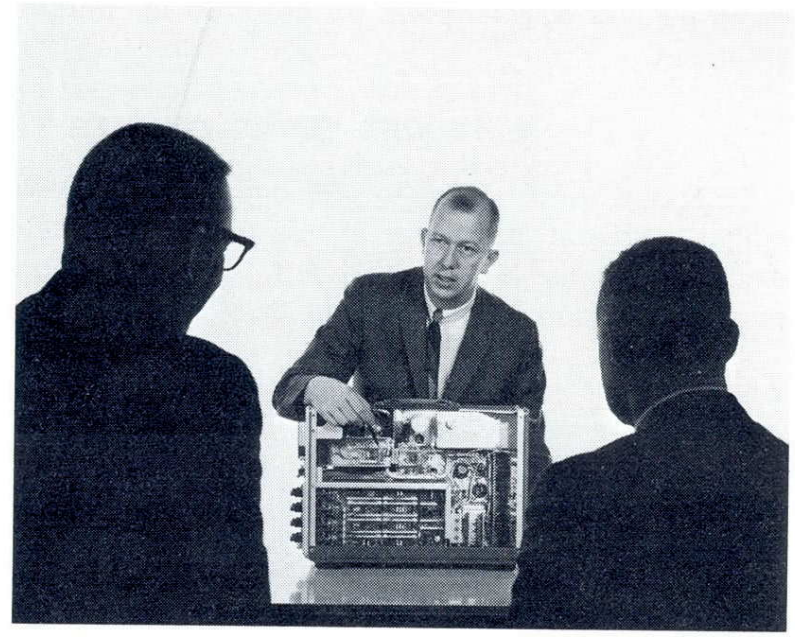
Tektronix Field Services

COMMUNICATIONS

Your Field Engineer is a valuable communication link between you and the factory. He knows the exact person to contact in each circumstance, and he can reach that person fast and easily. Let him help speed your communication on any problem related to your Tektronix Instruments.

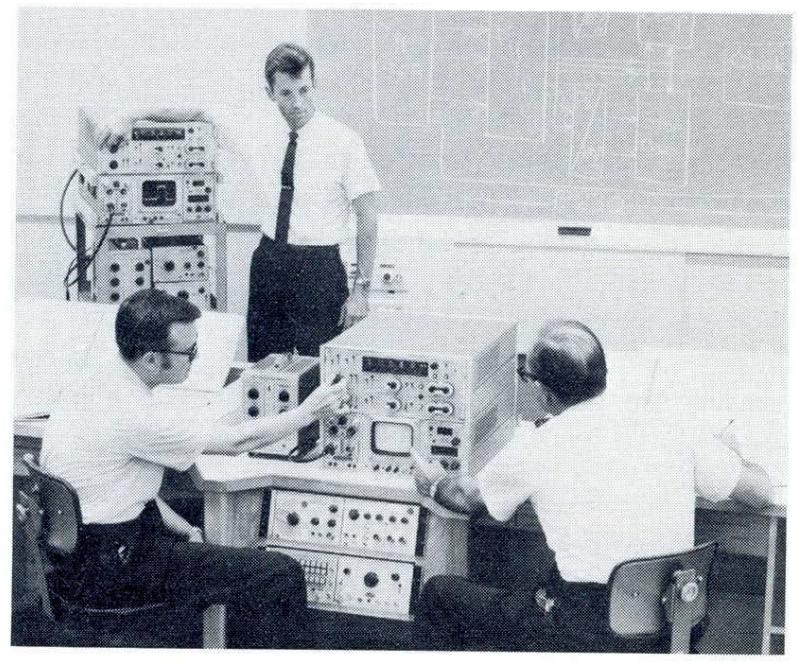
MAINTENANCE

Tektronix willingly assumes much of the responsibility for continued efficient operation of the instruments it manufactures. If you should experience a stubborn maintenance problem, your Field Engineer will gladly help you isolate the cause. Often a telephone discussion with him will help you get your instrument back in operation with minimum delay. If yours is a large laboratory, your Field Engineer can be of service to your maintenance engineers by conducting informal classes on test and calibration procedures, trouble-shooting techniques, and general maintenance.



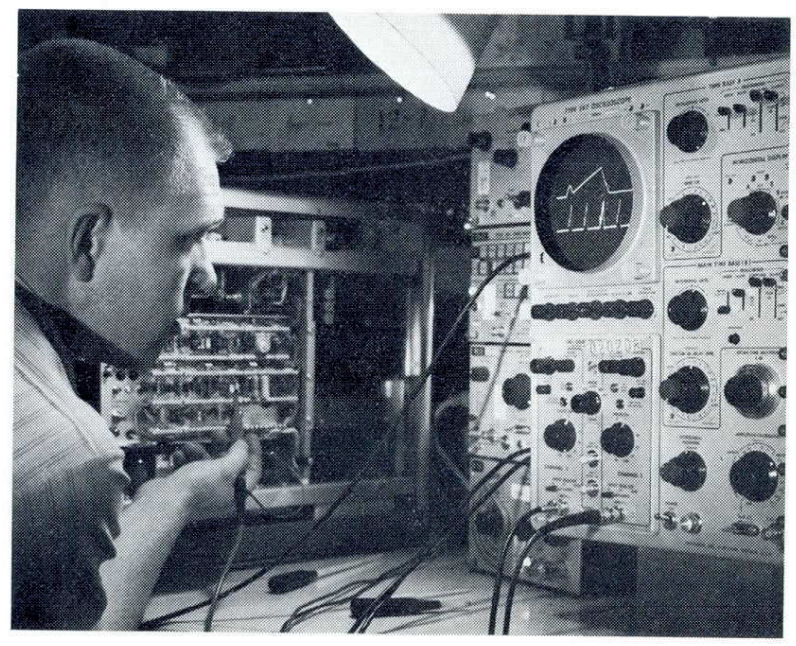
FACTORY TRAINING

Often there is a need for in-depth training that cannot be fully accomplished locally. To meet these needs, Tektronix has established a program of factory training which is an extension of Tektronix field engineering services. Customers who participate in this program attend classes at the Tektronix customer training center located in the Tektronix Industrial Park in Beaverton, Oregon. This training course is free of charge. The cost of accommodations, transportation and board must be borne by the customer. Ask your Field Engineer for full details, he will make all the arrangements.



INSTRUMENT RECONDITIONING—SERVICING

An older Tektronix Oscilloscope, properly reconditioned, can give you many additional years of service. Your Field Engineer will gladly explain the advantages of instrument reconditioning, major repair, and recalibration that can be performed at a nearby Field Service Center. Ask your Field Engineer about this service to Tektronix customers.



General Information

Customers Within the United States

GENERAL TERMS OF SALE AND SHIPMENT

Orders should be placed with your Tektronix Field Engineering Office listed on page 7.

Credit terms may be arranged through your Tektronix Field Engineer.

Tektronix offers many different terms of sale in order to meet varied purchasing objectives and to assist in financial planning. Some of these terms are:

NET 30 DAYS

Tektronix standard terms of sale are NET 30 days, which is to agree that payment will be deferred for thirty days following shipment.

EXTENDED TERMS OF SALE

Extended terms of 60 to 120 days are available on the same single payment basis as standard terms. Since the cost of extended terms is not included in catalog prices, a service charge is added to the product invoice.

LEASE AGREEMENT

All new instruments, digital systems, computer terminals, cameras, Scope-Mobile® Carts and modifications thereof are available under this program. Accessories and parts are not available unless they are associated with the products being leased. Minimum lease written will be $1000.

A standard lease term of 12, 18, 24, 30 and 36 months is offered. Longer terms are negotiable. Under a LEASE AGREEMENT, the customer pays for the USE of the product for the term of agreement. It is not a month-to-month rental . . . it is a non-cancellable, fixed-term lease requiring NO ADVANCE PAYMENT WHATSOEVER. At the expiration of the lease there is the opportunity to update the instruments, to renew the existing lease, or to return the equipment at Tektronix' expense. The customer may exercise an option to purchase the equipment at any time during the term of the lease, provided he gives thirty days written notice. A portion of the paid-in rentals will be credited toward the purchase price.

The standard Tektronix warranty and quantity discount apply to leased products.

CONDITIONAL SALES CONTRACT

This program provides monthly installment payment terms while Tektronix products are in use. All instruments, digital systems, computer terminals, cameras, Scope-Mobile® Carts and modifications thereof are available under this program. Accessories and parts are not available unless they are associated with the products being purchased. New and used products may be purchased with a deduction for applicable quantity discounts.

An advance payment equal to approximately 10% of the purchase price of the equipment desired is required for a CONDITIONAL SALES CONTRACT. Installment terms covering the balance of the contract price are available for 6, 12, 18, 24, 30 or 36 months. Minimum balance amounts may be financed, ranging from $200 for six months to $2000 for thirty-six months. Longer terms of 48 to 60 months are available by quotation for financed balances of more than $10,000. There are no maximum finance balances.

All products carry the standard Tektronix warranty. The customer is responsible for the equipment and applicable property taxes, licenses, etc. Upon completion of the term of agreement and prescribed payments, the customer owns the equipment.

All prices, quotations and shipments are FOB Beaverton, Oregon.

Unless otherwise specified, shipment will be made via most economical method. Surface and air shipments will be insured at full valuation unless your order instructs otherwise.

FIELD MAINTENANCE

To help assure adequate instrument-maintenance facilities for our customers, Tektronix has established Field Engineering Offices and Service Centers at strategic points in the United States. Your own Tektronix Field Office will process all orders for repair parts promptly, and provide emergency parts service when needed to restore an instrument to operating condition. Your Field Office will also arrange for fast service with necessary adjustments or repair of your instruments at a nearby Service Center.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office in your area. This procedure will assure you the fastest possible service. Please include instrument Type number and Serial number with all requests for parts or service. PLEASE DO NOT RETURN INSTRUMENTS OR PARTS BEFORE RECEIVING DIRECTIONS.

WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

Questions regarding warranty should be discussed with your Tektronix Field Engineer.

TEKTRONIX, INC.

An Oregon Corporation ● Corporate Offices and Plant Located at:

TEKTRONIX INDUSTRIAL PARK, 14150 S.W. KARL BRAUN DRIVE, BEAVERTON, OREGON

MAILING ADDRESS:

P.O. BOX 500, BEAVERTON, OREGON 97005

Telephone: (503) 644-0161 TWX: 503-291-6805 Telex: 36-691 Cable: TEKTRONIX

United States Field Offices and Service Centers

TEKTRONIX, INC.

P. O. Box 500, Beaverton, Oregon 97005

Telephone: (503) 644-0161 TWX—503-291-6805 Telex: 36-691 Cable: TEKTRONIX

FIELD ENGINEERING OFFICES

ALABAMA

Huntsville 35801
Suite 51, 3322 S. Memorial Parkway
Phone (205)881-2912, Telex 59-4422

ARIZONA

Phoenix
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Scottsdale 85251
Phone (602)946-4273, Telex 66-7401
Tucson Area: Enterprise 383

CALIFORNIA

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Suite D, 1525 S. Garfield Avenue
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From L.A. call: 283-0501

Concord 94520
2339A Stanwell Circle
Phone (415)687-8350, Telex 335-344
From Oakland, Berkeley, Richmond, Albany and San Leandro: 254-5353

Orange 92667
1722 E. Rose Avenue
Phone (714)633-3450, Telex 6-78432

Palo Alto 94303
3750 Fabian Way
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Santa Clara 95050
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From Island of Oahu, Hawaii Area: 365-700

Van Nuys 91406
16930 Sherman Way
Phone (213)987-2600, Telex 65-1426
From L.A. call: 873-6868

COLORADO

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Also serves Puerto Rico and U.S. Virgin Islands

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Mission 66202
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1526 York Road
Lutherville 21093
Phone (301)825-9000, Telex 87-804
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Methuen 01844
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22132 West Nine Mile Road
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MINNESOTA

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Pentagon Office Park
4930 West 77th Street
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5128 West Charleston Blvd.
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Albuquerque 87108
1258 Ortiz Drive, S.E.
Phone (505)268-3373, Telex 66-0421
Southern N.M. Area: Enterprise 678

NEW YORK

Albany
678 Troy Road
Latham 12110
Phone (518)785-3353, Telex 145-402

Buffalo 14225
965 Maryvale Drive
Phone (716)633-7861, Telex 91-385

Endicott
3214 Watson Blvd.
Endwell 13763
Phone (607)748-8291, Telex 933-421

Long Island
125 Mineola Avenue
Roslyn Heights, L.I. 11577
Phone (516)484-2300, Telex 96-1328

Poughkeepsie 12603
1 Old Mill Road
Phone (914)462-4670, Telex 96-8414

Syracuse 13211
112 Pickard Building
5858 E. Molloy Road
Phone (315)455-6666, Telex 937-239

NORTH CAROLINA

Greensboro 27405
1011 Homeland Avenue
Phone (919)274-4647, Telex 57-4416

OHIO

Cleveland 44129
5562 Pearl Road
Phone (216)884-6558, Telex 98-5217

Columbus
Suite 5, 12 West Selby Blvd.
Worthington 43085
Phone (614)888-4040, Telex 24-5497

Dayton 45439
3309 Office Park Drive, Suite 103
Phone (513)293-4175, Telex 2-88225

OKLAHOMA

Oklahoma City 73105
901 Office Park Plaza
Phone (405)848-3361, Telex 7-1459

OREGON

Portland
8845 S.W. Center Court
Tigard 97223
Phone (503)639-7691, Telex 36-0205

PENNSYLVANIA

Philadelphia
126 Presidential Blvd. North
Bala-Cynwyd 19004
Phone (215)839-3111, Telex 83-4218

Pittsburgh
3834 Northern Pike
Monroeville 15146
Phone (412)351-3345, Telex 86-761

RHODE ISLAND

Providence
2845 Post Road
Warwick 02886
Phone (401)739-4771, Telex 92-7662

TEXAS

Dallas 75240
4315 Alpha Road
Phone (214)233-7791, Telex 73-0570

Houston 77027
Suite H, 3723 Westheimer
Phone (713)622-8141, Telex 77-494

San Antonio 78209
8031 Broadway
Phone (512)826-0686, Telex 76-7456

UTAH

Salt Lake City 84115
65 West 2950 South
Phone (801)484-8501, Telex 388-365

VIRGINIA

Alexandria 22304
Suite 102, 6000 Stevenson Avenue
Phone (703)751-6096, Telex 8-9406

Hampton 23366
1310 Todds Lane
Phone (703)826-4020, Telex 82-3409

WASHINGTON

Seattle 98188
410 Baker Blvd.
Andover Industrial Park
Phone (206)243-2494, Telex 32-488
From Pullman, Richland, Spokane, Yakima: Zenith 9369

WISCONSIN

Milwaukee 53226
Mayfair Plaza
2421 North Mayfair Road
Phone (414)476-6850, Telex 2-6604

General Information

Customers Outside the United States

To provide you with personal assistance in ordering as well as servicing Tektronix instruments, we have established Field Engineering Offices and technically qualified Tektronix distributors in many countries throughout the world. The Tektronix office or distributor in your country will be pleased to help you select the instrument that best suits your requirements in performance, and provide you with prompt ordering service.

SERVICE

If you require service, replacement parts, a warranty question resolved, or other help, please notify the Tektronix facility through which you ordered your instrument. They will process all orders for repair parts promptly, and provide emergency parts service when needed to restore an instrument to operating condition. They will also arrange for fast service with necessary recalibration or repair work on your instrument.

WARRANTY

All Tektronix instruments are warranted against defective material and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

PLEASE DO NOT RETURN INSTRUMENTS OR PARTS BEFORE RECEIVING DIRECTIONS.

WHO TO CONTACT

COUNTRIES WITH TEKTRONIX FIELD ENGINEERING OFFICES

AUSTRALIA
CANADA
DENMARK
FRANCE
JAPAN
SWITZERLAND
UNITED KINGDOM
Listed on page 9

The Tektronix Field Engineering office in your country will provide you with quotations and accept your orders. Normally, prices quoted are FOB your plant.

COUNTRIES WITH TEKTRONIX DISTRIBUTORS

Listed on pages 9 and 10

Your Tektronix distributor will provide you with quotations FOB your country and accept your orders.

COUNTRIES WITH NO TEKTRONIX DISTRIBUTOR OR TEKTRONIX FIELD ENGINEERING OFFICE

Please address your inquiries and orders to:

Tektronix, Inc
International Marketing Dept.
P. O. Box 500
Beaverton, Oregon 97005 USA

INFORMATION AND QUOTATIONS

Staff Field Engineers will be pleased to provide you with information on Tektronix instruments and answer your technical questions. A pro forma invoice will be issued, if requested, indicating price and sales conditions. When pro forma invoice or purchase order acknowledgement is issued, we will indicate the documents needed to ship your order. We will be glad to prepare necessary export documentation for you and make all shipping arrangements.

METHOD OF PAYMENT

We would like to make our products available to customers on open account terms, whenever conditions permit. Other credit terms are available for a customer's particular requirements. However, due to political, foreign exchange, and regulatory conditions in many areas of the world, credit terms are not always available. In those cases, advance payment or irrevocable letters of credit are required.

SHIPMENTS

Unless otherwise requested, shipments will be made by the most economical method.

International Field Offices and Distributors

TEKTRONIX INTERNATIONAL FIELD OFFICES

AUSTRALIA

Tektronix Australia Pty. Limited

North Ryde, N.S.W. 2113
80 Waterloo Road
Phone 88-7066
Cable: TEKTRONIX Australia

Adelaide, South Australia 5000
128 Gilles Street
Phone 23-2811

Melbourne, 3004
Suite 20, 67 Queen's Road
Phone 51-1592

CANADA

Tektronix Canada Limited

Montreal 308, Quebec
5050 de Sorel Street, Room 12
Phone (514)731-3761, Telex 01-2867
Cable: TEKANADA

Calgary 3, Alberta
825 - 12th Avenue S.W.
Phone: (403)269-7558, Telex 038-21730

Downsview 463, Ontario
1177 Finch Avenue, West
Phone (416)638-6404, Telex 02-2776

Ottawa 6, Ontario
28A Northside Road, Bells Corners
Phone (613)828-5171, Telex 01-3419

Vancouver 10, British Columbia
10 East 2nd Avenue
Phone (604)879-0986, Telex 04-50262

DENMARK

Tektronix A/S

Dk 2100 **Copenhagen** 0
1, Ronnegade
Phone (01) 29.48.00, Telex 5788
Cable: TOCOPEN Copenhagen

FRANCE

Relations Techniques Intercontinentales

91, Orsay
Z. I. Courtaboeuf
Route de Villejust
(Boite Postale 13)
Phone 920 61 73, Telex TEKFRANS 69332
Cable: TEKFRANS Orsay

(69) Lyon 7°
Centre Regional de Lyon
166, Avenue Berthelot
Phone (78) 72.00.70

(6) Nice
Centre Regional de Nice
11, Avenue Valdiletta
Phone (93) 84.05.93

(35) Rennes
Centre Regional de Rennes
6, Avenue Barthou
Phone (99) 00.84.42

(31) Toulouse
Centre Regional de Toulouse
15, rue Joseph Vie
Phone (61) 42.04.50

JAPAN

Sony/Tektronix Corporation

Tokyo 141
9-31, Kitashinagawa - 5, Shinagawa-Ku
(P.O. Box 14, Haneda Airport, Tokyo 149)
Phone 445-0221 (Area 03/Tokyo)
Telex TK 2262, TK 2436, TK 4666
Cable: SONYTEK Tokyo

Osaka
2-70 Itachibori Minami-dori Nishi-ku
Phone 541-6781/2

SWITZERLAND

Tektronix International A.G.

6300 Zug
P.O. Box 57, CH-6301
Phone 042 21.91.92, Telex 78808
Cable: TEKINTAG

UNITED KINGDOM

Tektronix U.K. Limited

Harpenden, Herts
Beaverton House, Station Approach
Phone Harpenden 61251, Telex 25559
Cable: TEKTRONIX Harpenden

INTERNATIONAL DISTRIBUTORS AND REPRESENTATIVES

Supplied and Supported by Tektronix, Inc., P.O. Box 500, Beaverton, Oregon, U.S.A. 97005
Telephone: (503) 644-0161 Telex: 36-691 Cable: TEKTRONIX

ARGENTINA

Coasin S.A.

Buenos Aires
Virrey del Pino 4071
Phone 52-3185, 51-9363 & 52-4368, Telex 012-2284
Cable: COASIN, Buenos Aires

Cordoba
Camadrid 188
Phone 2 3707

Rosario
Alberdi 939
Phone 3 1348

BRAZIL

Importacao, Industria e Comercio Ambriex, S.A.

Rio de Janeiro, Est. Guanabara
Av. Graca Aranha 226-6°
Phone 42-7990 & 42-7291
Cable: RAIOCARDIO Rio de Janeiro

Sao Paulo, Est.
Av. Pacaembu 811
Phone 52-0655 & 51-0912
Cable: RAIOCARDIO Sao Paulo

Ambriex, S.A.

Porto Alegre - Rio Grande do Sul
Rua Coronel Vicente 421 - Sala 403
Phone 4-7411

CEYLON

Maurice Roche Limited

Colombo
P.O. Box 61
Cable: LAXAPANA Colombo

CHILE

Pentz & Cia. Ltda.

Santiago
Casilla 2839, Matias Cousino 68
Phone 63010
Cable: PETIER Santiago

COLOMBIA

Manuel Trujillo Venegas e Hijo Ltda.

Bogota 2, D.E.
Carrera 7a #48-71
Apartado Aereo No. 20702
Phone 320679
Cable: TRUVEHIJO Bogota

HONG KONG

Gilman & Co. Ltd., Engineering Dept.
P.O. Box 56
(8th Floor, Alexandra House)
(Des Voeux Road, Central)
Phone H-227011, Telex HX 3358
Cable: GILMAN Hong Kong

INDIA

Hinditron Services Private Ltd.

Bombay 6
Manesha
69/A Nepean Sea Road
Phone 365344, Telex 2594
Cable: TEKHIND Bombay

IRAN

Berkeh Company Ltd.

Tehran
20 Salm Road
Roosevelt Avenue
Phone 628294
Cable: BERKEHKAR, Tehran

KOREA

M-C International

Seoul
Room 516, Bando Bldg.
P. O. Box 1355
Phone 22-4316, 22-6891 & 28-1415
Cable: EMCEEKOREA Seoul

MALAYSIA

Mecomb Malaysia Sendirian Berhad

Selangor
2, Lorong 13/6A, Section 13
P.O. Box 24
Petaling Jaya
Phone 53570, 53478

MEXICO

Electronica Fredin, S.A.

Mexico 10, D.F.
Pedregal #50
Lomas de Chapultepec
Phone 20 89 48

NEW ZEALAND

W. & K. McLean, Ltd.

Auckland
103-105 Felton Mathew Avenue
Glen Innes
P.O. Box 3097
Phone 586-000
Cable: KOSFY Auckland

Wellington
5th Floor, Westbrook House
181 Willis Street
Phone 555-869

PAKISTAN

Pak-Land Corporation

Karachi 29
Central Commercial Area
Iqbal Road
P.E.C.H. Society
Phone 472315
Cable: PAKLAND Pakistan

PERU

Importaciones y Representaciones Electronicas, S.A.

Lima
Franklin D. Roosevelt 105
Phone 72076
Cable: IREING, Lima

PHILIPPINES

Philippine Electronic Industries, Inc.

Makati, Rizal
Buendia Avenue Corner Dian St.
P.O. Box 498, Makati Commercial Center
Phone 8-72-41/2/3/4
Cable: PHILECTRON, Makati

SINGAPORE

Mechanical & Combustion Engineering Co. Ltd.

Singapore 3
9, Jalan Kilang
Redhill Industrial Estate
(P.O. Box 46, Alexandra Post Office)
Phone 642361-3
Cable: MECOMB

TAIWAN

Heighten Trading Co. Ltd.

Taipei
P.O. Box 1408
Republic of China
Phone 518324, 518372
Cable: HEIGHTEN Taipei

THAILAND

G. Simon Radio Co. Ltd.

Bangkok
30, Patpong Avenue, Suriwong
Phone 33969 & 33960
Cable: SIMONCO Bangkok

URUGUAY

Coasin Uruguaya S.A.

Montevideo
Cerrito 617-4° Piso
Phone 9-79-78
Cable: COAUR Montevideo

VENEZUELA

Coasin C.A.

Caracas
Edificio La Linea-Av. Libertador
entre Las Palmas y Las Acacias
(Apartado 50939-Sabana Grande No. 1)
Phone 72-9637
Cable: INSTRUVEN, Caracas

International Distributors

INTERNATIONAL DISTRIBUTORS AND REPRESENTATIVES

Supplied and Supported by Tektronix Limited, P. O. Box 36, St. Peter Port, Guernsey, Channel Islands
Telephone: Guernsey 23411, Telex: 41193

Tektronix Limited maintains a warehouse of United States-made instruments, accessories and parts on the Island of Guernsey to quickly support these distributors in filling customer orders. Technical support of customers and distributors is also available from this facility. In addition, Tektronix has manufacturing facilities within the European Economic Community and European Free Trade Association.

ANGOLA

Equipamentos Tecnicos, Lda.

Luanda
Rua Serpa Pinto 39
Phone Luanda 6917
Cable: EQUIPAL Luanda

AUSTRIA

Inglomark Markovitsch & Co.

A-1151 **Wien**
P.O. Box 73
Phone (0222) 83-05-08, Telex (1) 1393
Cable: INGLOMARK Wien

BELGIUM

Regulation Mesure, SPRL

Brussels 15
73 Av. Vandendriessche
Phone 71.20.20, Telex 02-21520
Cable: MEREG Bruxelles

EAST AFRICA (Kenya, Tanzania, Uganda)

Engineering & Sales Co., Ltd.

Nairobi, Kenya
Bankhouse, Government Road
P.O. Box 6658
Phone 26815

FINLAND

Into O/Y

Helsinki
P.O. Box 10153, 11, Meritullinkatu
Phone 11123
Cable: INTO, Helsinki

GREECE

Marios Dalleggio Representations

Athens 139
2, Alopekis Street
Phone 710.669, Telex 216435
Telex Answer Code: DALM GR
Cable: DALMAR Athens

ISRAEL

Eastronics Ltd.

Tel Aviv
75 Haifa Road, P.O. Box 21029
Phone 440-466, Telex 033-638
Cable: EASTRONIX Tel Aviv

ITALY

Silverstar Ltd.

Milano 20146
Via dei Gracchi No. 20
Phone 46.96.551/2/3/4/5 and
49.80.151/2/3/4/5
Telex 32634 SILSTAR Milano
Cable: SILVERSTAR Milano

Roma 00198
Via Paisiello No. 30
Phone 855.366, 869.009, 854.554
and 854.529
Telex 61511 SILSTAR Roma
Cable: SILVERSTAR Roma

Torino 10129
Corso Castelfidardo No. 21
Phone 540.075 and 543.527
Cable: SILVERSTAR Torino

LEBANON

Projects

Beirut
P.O. Box 5281
Phone 241200
Cable: PROJECTS Beirut

MOROCCO

F. Pignal, Materiel Radio En Gros

Casablanca
21/29 Boulevard Girardot
Phone 702-61
Cable: PIRADIO Casablanca

MOZAMBIQUE

Equipamentos Tecnicos, Lda.

Lourenco Marques
Av. 24 de Julho, 1847
Phone 2601
Cable: EQUIPAL-Lourenco Marques

THE NETHERLANDS

C.N. Rood, N.V.

Rijswijk
13 Cort van der Lindenstraat
P.O. Box 4542
Phone The Hague 99.63.60, Telex 31238
Cable: ROODHOLLAND G.V.

NORWAY

Morgenstierne & Co. A/S

Oslo
Konghellegt.3.
(P.O. Box 6688 Rodelokka, Oslo 5)
Phone (02) 37 29 40, Telex 1719
Cable: MOROF Oslo

PORTUGAL

Equipamentos de Laboratorio Lda.

Lisbon
P.O. Box 1100 (Casal de Garoto)
Estrada Lisboa - Sintra Amadora
Phone 97 02 51, Telex 1702
Cable: EQUILAB, Lisboa

REPUBLIC OF SOUTH AFRICA

Protea Physical & Nuclear
Instrumentation (Pty) Ltd.

Johannesburg
Wemmer
Phone 838-8351, Telex J7337
Cable: MANLU

SPAIN

C.R. Mares, S.A.

Barcelona (9)
Valencia 333
Phone 257.62.00, Telex 54676
Cable: SERAM Barcelona

Madrid (15)
Gaztambide, 54-1°
Phone 243-08-38, Telex 7332
Cable: SERAM Madrid

SWEDEN

Erik Ferner, A.B.

Bromma
Snormakarvagen 35, Box 56
Phone 03/80 25 40, Telex 10312
Cable: SCIENTRON, Stockholm

Goteborg
O. Annebergsvagen 19, Box 30
Partille
Phone 031-444130

TUNISIA

Selection Internationale

Tunis
17, Rue Kamel
Ataturk
Cable: INTERSEL Tunis

TURKEY

M. Suheyl Erkman

Istanbul
Necatibey Cad No. 207, Galata
Phone 441546
Cable: INGMESUER Istanbul

WEST GERMANY

Rohde & Schwarz Handels-GmbH

1 **Berlin** 1
Ernst-Reuter-Platz, 10
Phone 34 05 36, Telex 0 181 636
Cable: ROHDESCHWARZ Berlin

Rohde & Schwarz Vertriebs-GmbH

2 **Hamburg** 50
Grosse Bergstrasse 213-217
P.O. Box 1266
Phone 38 14 66, Telex 0 213 749
Cable: ROHDESCHWARZ Hamburg

75 **Karlsruhe**
Kriegsstrasse 39
P.O. Box 5229
Phone 2 39 77, Telex 7 826 730
Cable: ROHDESCHWARZ Karlsruhe

5 **Koeln** 1
Hohe Strasse 160-168
P.O. Box 101544
Phone 23 30 06, Telex 08 882 917
Cable: ROHDESCHWARZ Koeln

8 **Muenchen** 2
Dachauer Strasse 109
Phone 52 10 41, Telex 0 522 953
Cable: ROHDESCHWARZVERTRIEB Muenchen

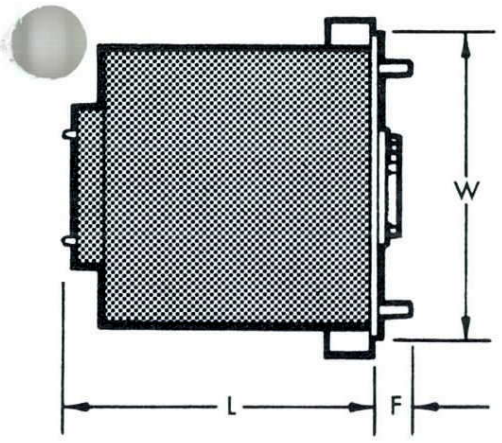
ZAMBIA

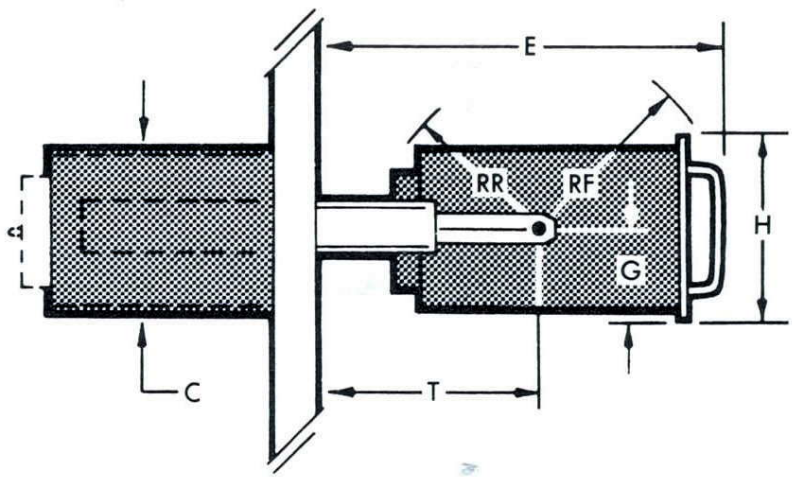
Baird and Tatlock (Zambia) Ltd.

Lusaka
Chachacha Road
P.O. Box 1038
Phone 74488 & 72443
Cable: PIPETTE, Lusaka

Ndola
Codrington Ave.
P.O. Box 1097
Phone 3522 & 2253/4/6
Cable: PIPETTE, Ndola

Instrument Dimensions





RACK MOUNT INSTRUMENTS *EXCLUSIVE OF PLUG-IN UNITS AND PROBES*		
Symbol	**Description**	**Definition**
H	Height	Height of front panel.
W*	Width	Width of front panel.
L	Length	Rack front to rearmost permanent fixture, excluding cables.
F	Forward Clearance	Back of front panel to foremost protrusion.
G	Vertical Axis	Bottom of front panel to horizontal plane of rotation.
E	Extended Inst.	Maximum forward clearance with instrument out and horizontal.
RF	Radius — front	Front radius of rotation.
RR	Radius — rear	Rear radius of rotation.
T	Track	Rack front to pivot point.
C	Cabinet	Cabinet height.

** Note: Instruments mount to a standard 19-inch wide rack.*

These instruments mount with sliding tracks in a cabinet that mounts to a standard 19 inch wide rack.

These instruments mount with sliding tracks to a standard 19 inch wide rack. Rear support for sliding tracks is required, such as an enclosed rack.

These instruments bolt directly to a standard 19 inch wide rack. They can be ordered at additional cost, with tilt-lock, sliding tracks. Rear support for tracks is required.

TYPE	MOUNTING DIMENSIONS																	
	H		L		F		G		E		RF		RR		T		C	
	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm
RM15	8 3/4	22.2	22 11/16	57.6	1 3/4	4.5	2 3/8	6.1	29 11/16	75.4	13 11/16	34.8	12 3/8	31.4	16 1/2	41.9	8 1/2	21.6
RM17	7	17.8	18 1/8	46.0	1 3/4	4.5	2 7/8	7.3	21 3/16	53.8	12 7/16	31.8	8 5/16	21.1	9 1/8	23.2	6 13/16	17.3
RM35A	14	35.6	22 11/16	57.6	2	5.1	6 15/16	17.8	29 7/16	74.7	14 1/16	35.7	12 7/16	31.9	16 1/4	41.3	13 13/16	35.1
RM122	5 1/4	13.3	6	15.2	15/16	2.4											4	10.2
RM125	5 1/4	13.3	13 9/16	34.5	7/8	2.2											4 1/16	10.3
RM502A	12 1/4	31.1	22 3/4	57.8	1 13/16	4.6	5 7/8	14.9	28 1/4	71.7	15 5/8	39.7	10 5/16	26.2	13 1/8	33.2	11 1/4	28.6
RM503, RM504	7	17.8	17	43.2	1 3/4	4.5	3 1/2	8.9	22 11/16	57.6	11 15/16	30.3	7 3/4	19.7	11 1/8	28.3	6 7/8	17.5
RM529	5 1/4	13.3	18 1/4	46.4	1 3/4	4.5	2 3/8	6.1	21 1/4	54.1	12 1/8	30.8	8 7/16	21.5	9 3/8	23.8	5 1/8	13.1
RM544, RM545B, RM546, RM547	14	35.6	22 11/16	57.7	1 15/16	5.0	6 13/16	17.3	28 3/4	33.0	13 1/2	34.3	12 15/16	32.9	16 1/4	41.3	13 15/16	35.4
RM561B	7	17.8	18 7/16	46.9	1 3/4	4.5	2 3/8	6.1	24 5/16	60.8	13 3/4	34.9	7 7/8	20.0	11	27.9	6 3/4	17.2
RM564B	7	17.8	18 7/16	46.9	1 3/4	4.5	2 3/8	6.1	24 5/16	60.8	13 3/4	34.9	7 7/8	20.0	11	27.9	6 3/4	17.2
RM565	12 1/4	31.1	22 3/16	56.4	1 13/16	4.6	2 3/8	6.1	30 1/2	77.4	15 3/16	39.1	13 1/16	33.2	16 5/8	42.2	12 3/16	31.0
RM585A	14	35.6	22 11/16	57.7	2	5.1	6 15/16	17.8	29 7/16	74.7	14 1/16	35.7	12 7/16	31.6	16 1/4	41.3	13 13/16	35.1
R116	5 1/4	13.3	17 9/16	44.6	1 5/8	4.1	1 3/4	4.5	25 3/4	65.4	11 9/16	29.4	8 1/4	21.0	14 5/8	37.2	5 1/16	12.8
R140	3 1/2	8.8	18 1/2	47.1	1 5/8	4.1			24 1/8	61.3							3	7.6
R141A	3 1/2	8.8	18 1/2	47.1	1 5/8	4.1			24 1/8	61.3							3	7.6
R142	3 1/2	8.8	18 1/2	47.1	1 5/8	4.1			24 1/8	61.3							3	7.6
R230, R240, R241, R250	7	17.8	21	53.3	2	5.1	1 3/4	4.4	28 5/8	88.8	14 7/16	36.6	10 3/16	25.8	15 1/8	23.6	7	17.8
R422	7	17.8	12 1/2	31.8	1 13/16	4.6	3 1/2	8.9	16 5/8	42.3							6 3/4	17.2
R453	7	17.8	17 3/8	44.1	1 13/16	4.6	3 1/2	8.9	20 11/16	52.6	11 5/8	29.5	7 7/8	20.0	9 5/16	23.7	6 3/4	17.2
R454	7	17.8	17 3/8	44.1	1 13/16	4.6	3 1/2	8.9	20 11/16	52.6	11 5/8	29.5	7 7/8	20.0	9 5/16	23.7	6 3/4	17.2
R491	7	17.8	17 3/8	44.2	2 1/16	5.2	3 1/2	8.9	21 1/16	53.5	11 15/16	30.4	8 1/2	21.6	9 5/16	23.7	6 13/16	17.3
R520	7	17.8	17 3/4	44.8	2	5.1												
R521	7	17.8	18	45.8	2	5.1			19 13/16	50.6							7	17.8
R522	7	17.8	18	45.8	2	5.1			19 13/16	50.6							7	17.8
R556	14	35.6	22 13/16	57.9	1 3/4	4.5	8 1/8	20.7	30 5/16	77.0	13 1/8	33.3	14 1/4	36.2	18 1/2	57.0	13 7/8	35.2
R568	7	17.8	21	53.3	2	5.1	1 3/4	4.4	28 5/8	88.8	14 7/16	36.6	10 3/16	25.8	15 1/8	23.6	7	17.8
R647A	7	17.8	19	48.3	1 11/16	4.3	2 7/16	6.2	27 7/8	70.9	13 5/8	34.5	8 11/16	22.1	16 3/8	41.6	13 7/8	35.2
[illegible]	8 3/4	22.2	21 5/8	55.0	1 3/4	4.5	2 3/8	6.1	28 11/16	72.9	12 3/4	32.4	12 1/4	31.1	16 1/2	41.9	8 1/2	21.6
[illegible]	10 1/2	26.6	21 5/8	55.0	2	5.1	1 3/4	4.5	29 1/2	74.9	17 5/8	44.8	11 1/16	28.3	13 1/4	33.7	10 1/2	26.8
016-0086-01	5 1/4	13.3	17 15/16	45.6	3/8	1.0											5 3/16	13.8
016-0115-01	5 1/4	13.3	17	43.2														
437-0031-00	8 3/4	22.2	9 1/2	24.2	1/4	0.7											7 1/16	18.0
437-0071-00	7	17.8	13 3/8	34.0	1 3/8	4.0											6 9/16	16.8

Shipping Volumes

Type	Domestic Pack Volume ft^3	Export Pack Volume ft^3
B	0.9	1.5
CA	0.9	1.5
C-12	2.1	4.8
C-27	2.1	4.8
C-30A	1.0	
C-31	1.0	
Engine Analyzer		
Access	2.2	3.4
G	0.9	1.5
H	0.9	1.5
K	0.9	1.5
L	0.9	1.5
M	0.9	1.5
O	0.9	1.5
Q	0.9	1.5
S-1	0.3	1.3
S-2	0.3	1.3
S-3	0.6	
S-4	0.3	1.3
S-5	0.3	1.3
S-50	0.3	1.3
S-51	0.3	1.3
T	0.9	1.5
W	0.9	1.5
1A1	0.9	1.5
1A2	0.9	1.5
1A4	0.9	1.5
1A5	0.9	1.5
1A6	0.9	1.5
1A7A	0.9	1.5
1L5	1.2	2.1
1L10	1.2	2.1
1L20	1.2	2.1
1L30	1.2	2.1
1L40	1.2	2.1
1S1	1.9	3.1
1S2	1.9	3.1
2A60	1.0	1.7
2A63	1.0	1.7
2B67	1.0	1.7
3A2	1.0	1.7
3A3	1.0	1.7
3A5	1.0	1.7
3A6	1.0	1.7
3A7	1.0	1.7
3A8	1.0	1.7
3A9	1.0	1.7
3A72	1.0	1.7
3A74	1.0	1.7
3A75	1.0	1.7
3B2	1.0	1.7
3B3	1.0	1.7
3B4	1.0	1.7
3B5	1.0	1.7

Type	Domestic Pack Volume ft^3	Export Pack Volume ft^3
3C66	1.0	1.7
3L5	1.0	1.7
3L10	1.2	2.1
3S1	1.0	1.7
3S2	1.0	1.7
3S5	1.0	1.7
3S6	1.0	1.7
3T2	1.0	1.7
3T5	1.0	1.7
3T6	1.0	1.7
3T77A	1.0	1.7
6R1A	2.4	3.6
7A11	1.1	2.0
7A12	1.1	2.0
7A13	1.1	2.0
7A14	1.1	2.0
7A16	1.1	2.0
7A22	1.1	2.0
7B50	1.1	2.0
7B51	1.1	2.0
7B52	1.1	2.0
7B70	1.1	2.0
7B71	1.1	2.0
7M11	1.1	2.0
7S11	1.1	2.0
7T11	1.1	2.0
10A1	1.0	1.7
10A2A	1.0	1.7
11B1	1.0	1.7
11B2A	1.0	1.7
81A	1.0	1.7
82	0.9	1.5
86	0.9	1.5
106	1.3	3.1
109	1.3	3.1
111	1.2	2.1
113	4.7	6.8
114	1.3	2.5
115	1.3	3.1
R116	5.2	9.9
122	0.8	1.5
FM122	0.8	1.5
RM122	1.9	3.1
125	1.3	4.8
FM125	1.3	4.8
RM125	3.5	5.6
127	5.4	9.9
129	6.7	9.9
130	1.2	2.1
132	1.9	3.1
133	1.9	3.1
140	5.2	9.9
141A	5.2	9.9
142	5.2	9.9
160A	1.3	4.8

Type	Domestic Pack Volume ft^3	Export Pack Volume ft^3
161	0.8	1.5
162	0.8	1.5
163	0.8	1.5
175	4.9	9.9
184	1.3	3.1
191	1.3	3.1
201-1	13.2	14.5
201-2	13.2	14.5
202-1	13.2	14.5
202-2	13.2	14.5
205-1	18.4	20.2
205-2	18.4	20.2
205-3	18.4	20.2
230	5.2	9.9
R230	5.2	9.9
240	5.2	9.9
R240	5.2	9.9
241	5.2	9.9
R241	5.2	9.9
R250	5.2	9.9
262	5.0	9.9
263	1.3	3.1
284	1.3	3.0
285	0.3	1.3
310A	1.9	3.1
317	2.4	3.6
RM17	5.2	9.9
321A		
w bat	1.9	
wo bat	1.9	3.1
323	1.3	3.0
360	1.3	3.6
410	1.9	3.6
422		
w cover	3.7	5.5
422 125B		
wo bat	3.7	5.5
R422	5.2	9.9
R422 150B	5.2	9.9
R422 150E	5.2	9.9
453		
w cover	3.7	5.5
R453	5.2	9.9
454		
w cover	3.7	5.5
R454	5.2	9.9
491		
w cover	3.7	5.5
R491	5.2	9.9
502A	4.1	7.5
RM502A	6.7	9.9
503	3.5	5.6
RM503	5.2	9.9
504	3.5	5.6
RM504	5.2	9.9

Type	Domestic Pack Volume ft^3	Export Pack Volume ft^3
507	5.4	7.5
507 P.S.	3.5	5.6
515A	3.5	5.6
RM15	5.2	9.9
516	3.5	5.6
519	7.8	10.4
520 NTSC	5.2	9.3
521	5.2	9.3
R521	5.2	9.3
522	5.2	9.3
R522	5.2	9.3
528	1.9	3.6
529	2.4	5.6
RM529	5.2	9.9
531A	5.4	7.5
533A	5.4	7.5
535A	5.4	7.5
RM35A	6.7	9.9
536	5.4	7.5
543B	5.4	7.5
RM543B	6.7	9.9
544	5.4	7.5
RM544	6.7	9.9
545B	5.4	7.5
RM545B	6.7	9.9
546	5.4	7.5
RM546	6.7	9.9
547	5.4	7.5
RM547	6.7	9.9
549	5.4	7.5
551	5.4	7.5
551 P.S.	3.5	5.6
556	10.3	11.2
R556	10.3	11.2
561B	3.5	5.6
R561B	5.2	9.9
564B	3.5	5.6
R564B	5.2	9.9
565	6.7	9.9
R565	6.7	9.9
567	6.7	9.9
R567	6.7	9.9
568	5.2	9.9
R568	5.2	9.9
575	5.4	7.5
575 122C	5.4	7.5
576	6.8	
581A	5.4	7.5
585A	5.4	7.5
R585A	6.7	9.9
601	1.9	3.6
602	1.9	3.6
611	5.5	7.5
647A	3.5	5.6
R647A	5.2	9.9
R4501	5.2	9.9
R5030	4.7	9.2
R5031	4.7	9.2
7504	5.6	8.2
7704	5.6	8.2

Symbols and Abbreviations

The user of this catalog may find some unfamiliar symbols and abbreviations. In general, Tektronix has adopted the Symbols For Units, IEEE Standard Number 260, dated January 15, 1965. The abbreviations have been adopted by Tektronix following a thorough study of available abbreviations and guidelines published by the National Bureau of Standards, United States Government, American Standards Association, and others.

Many of these symbols and abbreviations are new, and inconsistencies between this list and other sources such as instrument panels and existing instrument manuals will be found. Future instruments and manuals will reflect adherence to these new symbols and abbreviations.

Below are some of the symbols and abbreviations used in this catalog. Those symbols found in IEEE Standard Number 260 are marked with an asterisk.

alternating current	AC
*ampere	A
amplitude modulation	AM
approximate	approx
approximately equal to	≈ or ≃
attenuation	atten
audio frequency	AF
automatic	auto
bandwidth	bw
base	b
*bel	B
beta	β
calibrate	cal
cathode-ray oscilloscope	CRO or scope
cathode-ray tube	CRT
*centimeter	cm
clockwise	cw
common-mode rejection	CMR
common-mode rejection ratio	CMRR
continuous wave	CW
counterclockwise	ccw
current	I
*decibel	dB
*decibel referred to one milliwatt	dBm
deflection factor	DF
*degree	°
*degree Celsius (centigrade)	°C
*degree Fahrenheit	°F
*degree Kelvin	°K
delay	dly
delay line	DL
differential	diff
direct current	DC
division	div
electrocardiogram	ECG
electroencephalogram	EEG
electromagnetic interference	EMI
*farad	F
*foot	ft
*foot lambert	fL
frequency modulation	FM
giga	G
*gigahertz	GHz
graticule	grat
gravity unit	g
greater than	>
greater than or equal to	≥
ground	gnd
*henry	H
*hertz	Hz
horsepower	hp
*hour	h
impedance	Z
*inch	in
inductance	L
intermediate frequency	IF
kilo	k
*kilogram	kg
*kilohertz	kHz
kilohm	kΩ
kilometer	km
*kilovolt	kV
less than	<
less than or equal to	≤
local oscillator	LO
low frequency	LF
maximum	max
mega	M
*megahertz	MHz
*megohm	MΩ
*meter	m
micro	μ
*microsecond	μs
milli	m
*millimeter	mm
*millisecond	ms
*millivolt	mV
minus	—
nano	n
*nanosecond	ns
National Television System Committee	NTSC
negative	neg
ohm	Ω
operational amplifier	op amp
oscilloscope	scope or CRO
pair	pr
parts per million	P/M
peak to peak	P-P
per	/
phase alternate line	PAL
*pico	p
*picoampere	pA
*picofarad	pF
*picosecond	ps
plus	+
plus and minus	+ and —
plus or minus	±
positive	pos
pulse per second	p/s
pulse-repetition rate	PRR
pulse width	PW or t_p
radio-frequency interference	RFI
resistance	R
resistance-capacitance	RC
resistance-inductance	RL
*revolution per minute	r/min
risetime	t_r
root mean square	RMS
*second (time)	s
serial number	SN
signal	sig
signal-to-noise ratio	S/N
standing-wave ratio	SWR
storage time	t_s
sweep	swp
synchronize	sync
temperature	T
time domain reflectometry	TDR
tolerance	tol
transconductance	g_m
vertical interval test signal	VITS
*volt	V
*watt	W

*IEEE Standard Number 260

Electrical and Mechanical Considerations

VENTILATION

In general, a standard oscilloscope using 250 watts or more of power will have filtered forced-air cooling.

CLEARANCE

Under normal conditions, at least two inches of unobstructed space around the oscilloscope should be maintained to assure safe operating temperature. When rackmounting an instrument, add approx 3 inches to the depth of the instrument for adequate clearance of rear connections (power cords, etc.). Should the chassis temperature become excessive, a thermal-cutout switch will interrupt the power and keep it off until a safe operating temperature is reached.

CONSTRUCTION

The oscillscope chassis and cabinet are of aluminum alloy for lightweight durability.

FINISH

The instrument's front panels are anodized and the cabinets have a blue vinyl finish.

POWER REQUIREMENTS

In general, instruments are factory wired for operation at 115 VAC. Newer instruments provide quick-change line-voltage selectors for convenient selection of line-voltage operating ranges. Transformer taps in other instruments can be changed to accommodate specific line-voltage operating ranges or can be factory wired for a specific range if specified on the purchase order. Tektronix instruments are designed with electronically-regulated power supplies to compensate for changing line voltages.

Most Tektronix instruments are designed for operation from a power source with its neutral at or near ground (earth) potential. They are not intended for operation from two phases of a multi-phase system, or across the legs of a single-phase three-wire system (220 V).

Tektronix instruments are equipped with either a three-conductor attached power cord, or a three-terminal power cord receptacle. The third wire, or terminal, is connected directly to the instrument frame, and is intended to ground the instrument to protect operating personnel, as recommended by national and international safety codes. If the instrument must be operated from a two-contact outlet, a three-to-two-conductor adapter should be securely connected to a suitable ground, or the instrument frame should be securely grounded with an external connection. Color coding of the power cord conductors follows the National Electrical Code (USAS C1 - 1965): the line conductor is black; the neutral is white; the safety earth or ground is green.

Publications Available

Recognizing the ever-increasing quest for knowledge and technical information, Tektronix accepts this challenge concerning its products by publishing and distributing informative, easy-to-read material.

INSTRUCTION MANUALS

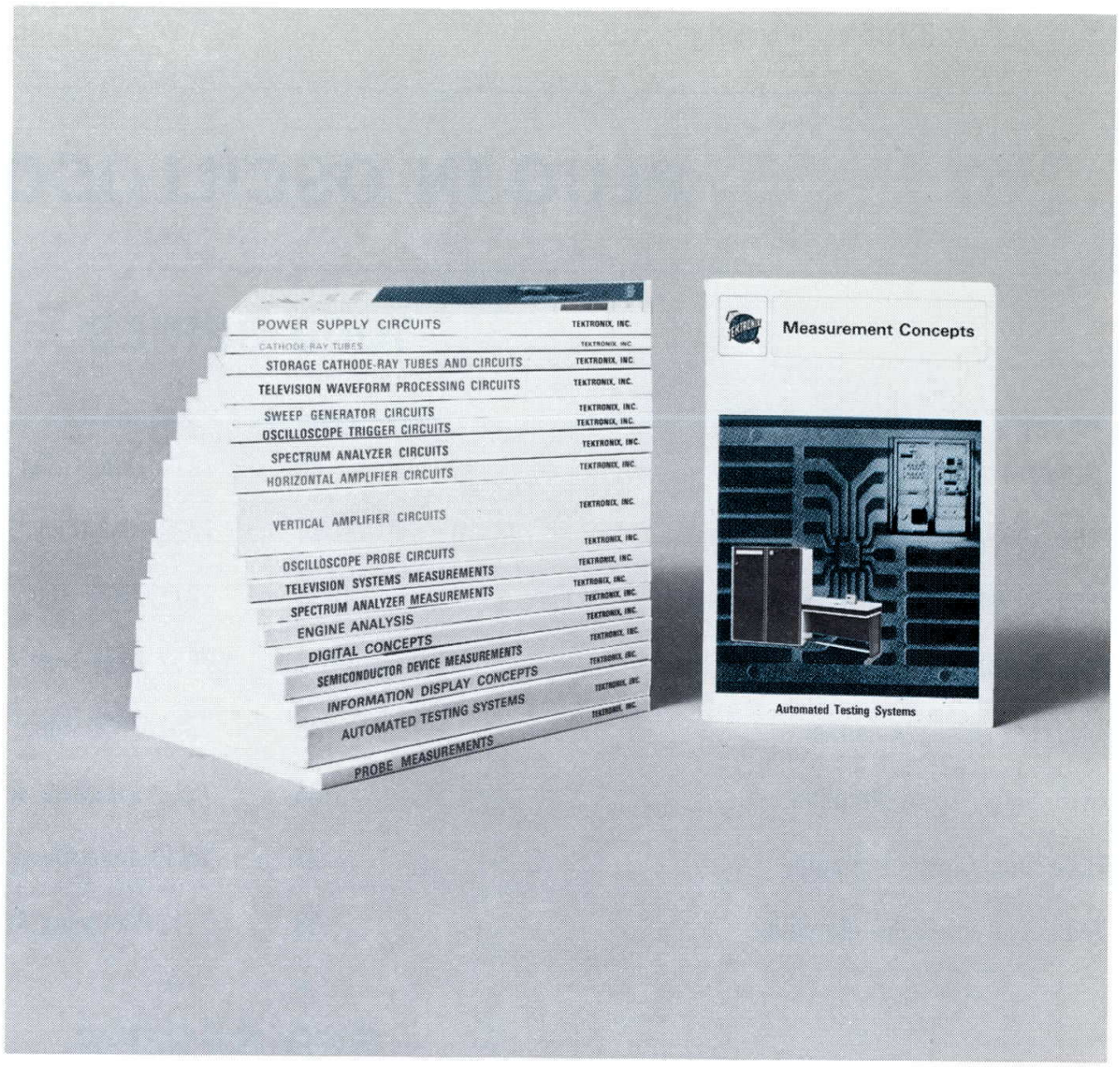
Tektronix instruction manuals are written for both the user and maintenance personnel. Shipped with each instrument, instruction manuals contain instrument specifications, operating instructions, circuit descriptions, maintenance information and calibration instructions as well as complete schematics and electrical and mechanical parts lists. Additional copies are available, at reasonable cost, through your nearby Tektronix Field Office.

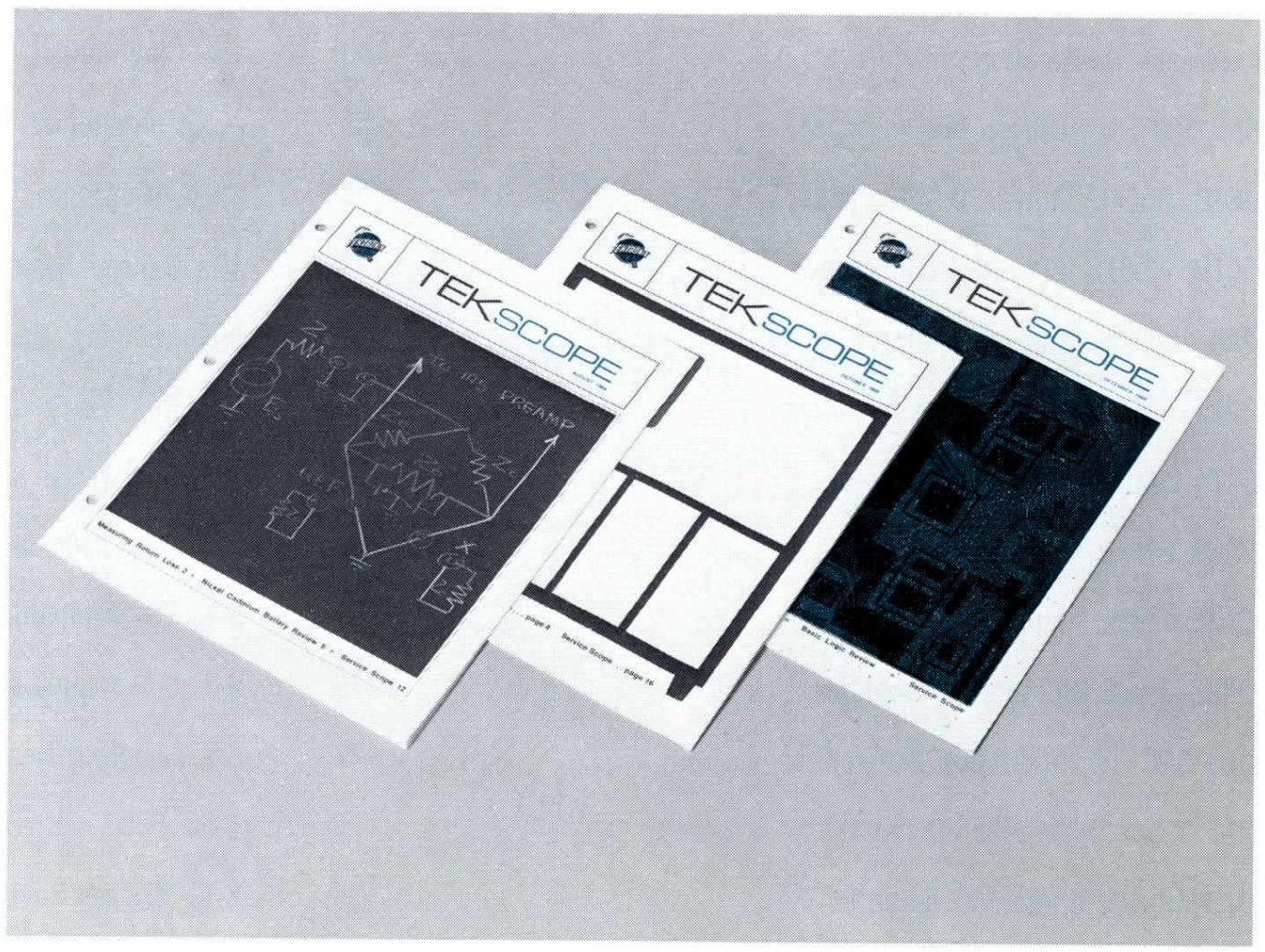
Publications Available

CONCEPTS BOOKS

Tektronix has recently started a program to produce circuit and measurement concepts books. The volumes dealing with circuits give a theoretical description of the selected subject matter. The measurement books describe a variety of measurement techniques. Concepts books may be obtained through your nearest Tektronix Field Office for a nominal fee. Eighteen are currently available; more are being written.

1. Power Supply Circuits
2. Cathode-Ray Tubes
3. Storage CRTs and Circuits
4. Television Waveform Processing Circuits
5. Sweep Generator Circuits
6. Oscilloscope Trigger Circuits
7. Spectrum Analyzer Circuits
8. Horizontal Amplifier Circuits
9. Vertical Amplifier Circuits
10. Oscilloscope Probe Circuits
11. Television Systems Measurements
12. Spectrum Analyzer Measurements
13. Engine Analysis
14. Digital Concepts
15. Semiconductor Device Measurements
16. Information Display Concepts
17. Automated Testing Systems
18. Probe Measurements





TEKSCOPE

A bimonthly publication whose objective is to provide informative, timely articles presented in a readable manner across the whole of Tektronix technology. Each issue of TEKSCOPE contains articles describing instruments, measurements, and techniques. Service Scope, a feature of TEKSCOPE, provides information for those responsible for the quality of instrument performance.

Wish to be on our mail list? Contact the nearest Tektronix Field Office. The addition of your name insures receipt of a new catalog, catalog supplements, Tektronix calendar, and TEKSCOPE.

General Purpose Oscilloscopes

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BEHIND THE FRONT PANEL . . .

An oscilloscope is a universal measuring instrument capable of measuring a very wide variety of rapidly changing electrical phenomena, even if the phenomenon occurs once and lasts only a fraction of a millionth of a second.

The oscilloscope graphs the changes with relation to time—measuring the amount of the event on its vertical axis, and how long the event lasts on its horizontal axis. The user can determine whether the voltage is changing positively or negatively, and the amplitude and duration of the event measured and the actual shape of the waveform.

The figure is a block diagram of a typical oscilloscope, omitting power supplies. The waveform *(A)* to be observed is fed into the vertical-amplifier input. The calibrated VOLTS/DIV control sets the gain of this amplifier. The push-pull output *(B and C)* of the vertical amplifier is fed through a delay line to the vertical-deflection plates of the cathode-ray tube. The purpose of the delay line is explained later on this page.

The time-base generator or "sweep generator" develops a sawtooth wave *(E)* that is used as a horizontal-deflection voltage. The rising or positive-going part of this sawtooth, called the "run-up" portion of the wave, is linear. That is, the waveform rises through a given number of volts during each unit of time. This rate of rise is set by the calibrated TIME/DIV control. The sawtooth voltage is fed to the time-base amplifier. This amplifier includes a phase inverter so that the amplifier supplies two output sawtooth waveforms *(G)* and *(J)* simultaneously—one of them positive-going, like the input, and the other negative-going. The positive-going sawtooth is applied to the right-hand horizontal-deflection plate of the cathode-ray tube, and the negative-going sawtooth is applied to the left-hand deflection plate. As a result, the cathode-ray beam is swept horizontally to the right through a given number of graticule divisions during each unit of time—the sweep rate being controlled by the TIME/DIV control.

In order to maintain a stable display on the cathode-ray tube screen, each horizontal sweep must start at the same point on the waveform being displayed. To maintain a stable display, we feed a sample of the displayed waveform to a "trigger" circuit that gives a negative output voltage spike *(D)* at some selected point on the displayed waveform. This triggering spike is used to start the run-up portion of the time-base sawtooth. As far as the display is concerned, then, "triggering" can be taken as synonymous with the starting of the horizontal sweep of the trace at the left-hand side of the graticule.

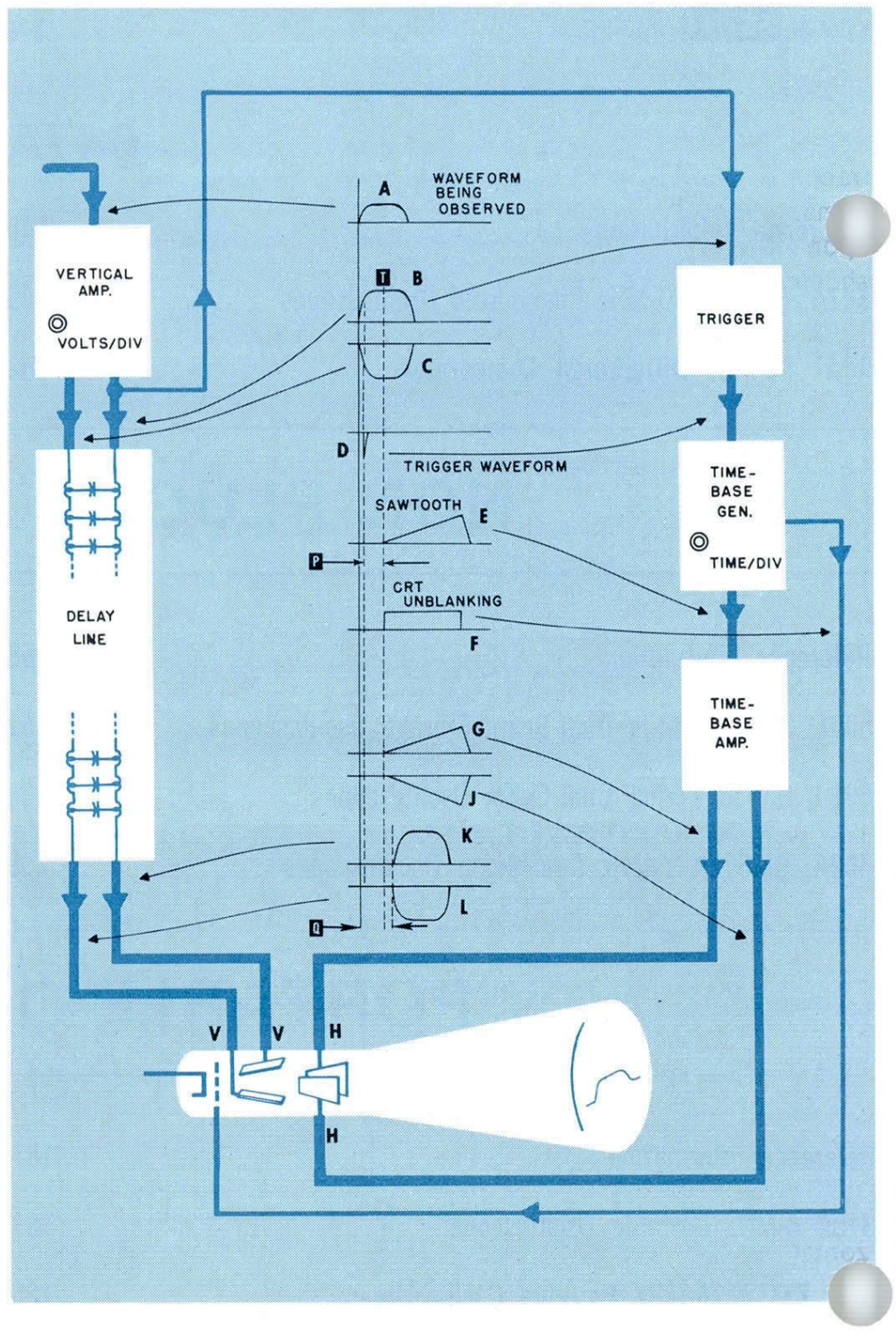
A rectangular "unblanking" wave *(F)* derived from the time-base generator is applied to the grid of the cathode-ray tube. The duration of the positive part of this rectangular wave corresponds to the duration of the positive-going or run-up part of the time-base output, so that the beam is switched on during its left-to-right travel and is switched off during its right-to-left retrace.

In the case shown, the leading edge of the waveform being displayed is used to actuate the trigger circuit. Yet we may want to observe this leading edge on the screen—and the triggering and unblanking operations require a measurable time interval *P,* often about 0.15 microsecond. To permit us to see the leading edge, a delay Q of about 0.25 microsecond is introduced by the delay line in the vertical-deflection channel, after the point where the sample of the vertical signal is tapped off and fed to the trigger circuit.

To summarize the purpose of the delay line, it is to retard the application of the observed waveform to the vertical-deflection plates until the trigger and time-base circuits have had an opportunity to get the unblanking and horizontal-sweep operations under way. In this way, we can view the entire desired waveform—even through the leading edge of that waveform was used to trigger the horizontal sweep.

If the delay line were not used, we would be able to see only that portion of the waveform following the instant designated as *(T)* in waveform *(A).*

THE OSCILLOSCOPE BLOCK DIAGRAM



Reference Information

The following discussion is intended to clarify the significance of many of the technical terms used to describe oscilloscopes. The information is intended for those who, being responsible for buying or recommending such instruments, feel a need for a better understanding of the relative importance of different features.

Things like workmanship, component quality and construction layout have important bearings on reliability and serviceability but, unfortunately, cannot be adequately specified. The quality and availability of technical assistance before and after purchase are other matters deserving considerable attention. However, they too can be appraised only **after** *experience.*

SCALES AND SWEEPS

Except in special cases, oscilloscopes have built-in sawtooth sweep generators for producing constant-speed horizontal beam deflection. In early scopes, these generators ran continuously and horizontal calibration was based on their repetition *frequency.* In most modern laboratory scopes, sweeps are calibrated in terms of a direct unit of *time* for a given distance of spot travel across the screen; hence the term, "time-base." The present system permits such advantages as:

1. Direct measurement of time between events (waveforms)
2. Viewing and measuring small portions of wavetrains
3. Viewing and measuring random or aperiodic events
4. Viewing and measuring single non-recurrent events

The units of distance are usually inches or centimeters (or fractions thereof) but sometimes are specified simply as "divisions." The choice of how long a division might be is based upon the manufacturer's best opinion of how the full scale should be divided. One major division is the unit of distance in a specification. Some instruments have different distance-units for the vertical and horizontal scales.

A transparent scale with vertical and horizontal lines spaced one division apart usually is fitted against the face of the CRT or in more modern instruments inside the CRT. This scale allows time and amplitude to be read directly. These graduated scales (graticules) often have small markings which subdivide the major divisions to assist in making accurate measurements. Such subdivisions should *not* be interpreted as the distance-unit in a specification.

Although it is common practice to think and speak of time-bases in terms of relative sweep speeds (horizontal velocity of the spot), we should not specify them in this way. Instead they are specified by a term which is actually the reciprocal of speed: time per division (Time/Div).

FAST AND SLOW SWEEPS

Some investigations require fast sweeps and others slow sweeps. Obviously an oscilloscope with the widest range of sweeps is usually the most versatile. However, the primary usefulness of a scope is as a high-speed device, so very slow sweeps have only limited use. From the standpoint of compatibility with frequency response, the fastest sweeps are usually considered adequate if they are capable of displaying one cycle of the upper passband frequency across the full horizontal scale. High-frequency scopes seldom have sweeps which are that fast.

To measure risetime as accurately as *possible,* a step-signal (squarewave, rectangular pulse, etc.) should occupy almost the full vertical scale, and the rising portion of the signal should be displayed at nearly a 45-deg slope. This requirement can be met only if the fastest sweep is able to move the beam a horizontal distance nearly equal to the full vertical scale in a time interval equal to the risetime of the vertical deflection system. Because of the compounding difficulties and costs of providing extremely fast sweeps which are both linear and accurate, the requirement is seldom met by scopes having very good vertical deflection risetime capabilities.

When accurate risetime measurements must be made which require the fastest sweep, a useful figure of merit for the adequacy of that sweep is $M = T_r/T_d$ where $M =$ figure of merit, $T_r =$ vertical system (usually amplifier) risetime and $T_d =$ time per division of the fastest sweep. Figures of merit greater than 1 are seldom found in scopes having risetimes less than approximately 30 nanoseconds (0.03 μs). Figures of merit greater than about 6 exceed the ideal and offer no further advantage. It should be realized that this figure of merit is only a measure of *compatibility;* whenever possible, accurate risetime measurements should not be attempted when the risetime of a step-signal exceeds the vertical deflection system risetime. (See section on Risetime and High Frequency Response.)

Fortunately, most risetime measurements are not made to determine *actual* risetime, but are made to determine whether certain limits are met or exceeded. In such cases, an adequate comparison with a standard signal of known risetime can usually be made, using a sweep having a relatively poor figure of merit, if the vertical deflection system risetime is good enough.

SINGLE-SWEEP OPERATION

In applications where the displayed signal is not repetitive or varies in amplitude, shape, or time a conventional repetitive display may produce a jumbled presentation. To avoid this, use of the single-sweep feature, found on most oscilloscopes, is advised. To operate the single-sweep feature, first make certain the trigger circuit will trigger on the event to be displayed. Arming of the sweep is done typically with the push of a switch, a lamp should light and stay lit indicating the trigger circuit is armed and ready for a trigger signal. When the circuit is triggered the sweep will run, the ready light will go out indicating that the circuit has been triggered. The sweep is locked out from that point on until the sweep circuit is again armed. This feature is particularly useful for photographic recording.

SWEEP MAGNIFICATION AND SWEEP DELAY

Sometimes it is desirable to display parts of waveforms which occur considerably later than suitable sweep triggering signals occur. Such waveforms, can always be displayed on sweeps which last long enough, but if the duration of the waveform is short compared to the duration of a full sweep, an accurate examination may not be possible. The need to magnify (expand) the display for the time interval during which a particular event occurs is apparent. Portions of sweeps may be magnified by increasing the gain of the horizontal amplifier (allowing either or both ends of the sweeps to go off-screen) and positioning the display so that the desired portion is on-screen. This is a simple way to meet the need. Another way

is to generate suitably delayed sweep triggering signals so that fast sweeps may be triggered just prior to the moment when the signal to be examined occurs. The first method delays the *presentation* of a sweep portion; the second method delays the actual *generation* of the displayed sweep. Calibrated sweep delay can provide some advantages over ordinary sweep magnification, cost and simplicity not being among them. These advantages are:

1. Greater ratios of effective magnification
2. Elimination of "time jitter" or "time drift" of displayed waveforms
3. Greater accuracy of time-interval measurements between waveforms
4. Better long-term accuracy of the displayed time base

SWEEP SWITCHING

Sweep switching oscilloscopes offer dual-beam measurement capabilities with a single-beam CRT for most repetitive signals. Found in the newer instruments sweep switching provides dual-trace, independent time-base displays and simultaneous delaying and delayed sweep displays. It can also provide four-trace displays using dual-trace vertical systems with sweep-switched horizontal systems.

RISETIME AND HIGH FREQUENCY RESPONSE

The first qualification generally sought in a scope is adequate risetime or adequate high-frequency sinewave response. Risetime is the more important specification for "faster" scopes, and passband (bandwidth) the more frequently used specification for "slower" scopes. The two will be closely related mathematically, however, when fast step-signals produce little or no overshoot or ringing. The product of risetime and frequency response should produce a factor whose value lies between 0.33 and 0.35, when transient response is optimum. For example, the product of 0.023 microsecond risetime (0.023×10^{-6} second) and 15 MHz (15×10^{6} Hz) equals 0.345. Factors larger than 0.35 probably indicate overshoot in excess of 2 percent, while those larger than 0.4 probably indicate overshoot in excess of 5 percent.

Ideally, scopes should have a vertical system capable of rising in about one-fifth the time that the fastest step-signal applied rises. In such a case, the risetime of the signal (as indicated on the scope) will only be in error by about 2 percent, assuming sweep timing and linearity are perfect. Vertical deflection systems which have a risetime no better than *equal* to the fastest rising signal applied are often considered adequate—a conclusion which may or may not be true depending upon the accuracy desired. Such reasoning is based upon the fact that the indicated risetime will be in error by a predictable amount when transient response is optimum. Under such conditions, signal risetime can be calculated to a close approximation by the formula

$$T_s = \sqrt{T_i^2 - T_a^2}$$

where T_s = signal risetime, T_i = indicated risetime and T_a = vertical system (usually amplifier) risetime. The accuracy of such calculations falls off sharply for signals which rise *faster* than the scope amplifier, because of the increased significance of measurement errors. For instance, the follo[w]ing sweep timing or display reading errors will contribute as much as 100 percent difference between calculated and *actual* signal risetimes.

When $T_a/T_s = 2/1$	11 percent	measurement error which can account for 100 percent calculation error
When $T_a/T_s = 3/1$	5 percent	
When $T_a/T_s = 4/1$	3 percent	
When $T_a/T_s = 5/1$	2 percent	

When the fastest sweep is relatively slow compared with vertical deflection system risetime (or the scale is small to start with), measurements become confined to quite small sections of the screen, and the probability of measurement errors becomes even worse.

As mentioned in a previous section, very accurate risetime measurements are usually not as common as risetime comparisons. For *comparing* the risetimes of two signals, scopes having a risetime equal to the risetime of signals applied to them are usually adequate.

SWITCHED INPUTS AND DUAL-BEAM SCOPES

A very useful type of dual-input amplifier is one which can pass either of two input signals one at a time to permit viewing either signal without disturbing connections. Comparison of the two signals is thereby permitted. Manual switching, available on some instruments, is the simplest method but electronic switching permits simultaneous viewing of two signals. Si[n]ce the two signals trace out separate displays, scopes with built-in electronic switches are commonly called dual-trace scopes. They should not be confused with dual-beam scopes. Dual-trace scopes offer some advantages over dual-beam scopes and vice versa. Two simultaneous, non-recurrent signals of *short duration* may be displayed on a dual-beam scope, but cannot be displayed on a dual-trace scope. Also, some dual-beam scopes can display non-recurrent signals on different time-bases. The principal advantages of dual-trace scopes are lower cost and intrinsically better comparison capabilities.

Steady displays of two signals which are not synchronous with each other may be displayed on dual-trace scopes. This is possible because the triggering signals may be switched in synchronism with the input signals. A useful application of such a display is one in which one waveform might be some kind of standard. Dual-beam scopes having two sweep generators and two sets of horizontal deflection plates also permit this kind of comparison.

Electronic switches should be capable of switching in two ways: rapidly during sweeps or synchronously during sweep retrace intervals. The first way is usually called "chopped," the second way "alternate." The alternate mode is used more frequently and is preferred for displays employing faster sweeps. The chopped mode usually is reserved for comparing low-frequency recurrent signals or long-duration, non-recurrent signals.

When displaying two very bright traces using the chopped mode, the display may show the chopping waveform transients as faint lines connecting the two traces. Some scopes blank (turn off) the CRT beam during these transition intervals to pre[v]ent them from appearing in the display.

The chopping rate (frequency) should be as high as possible so long as the resulting traces are not broadened significantly by distortion of the chopping signal. When the chopped mode is used with relatively fast non-recurrent sweeps, the traces are not continuous but are made up of separate segments, the number of segments depending on the chopping rate and the sweep duration. For instance, if the chopping rate is 100,000 Hz and the sweep duration is 1 millisecond, there will be 100 segments in each trace. How well these separate segments depict all the detail in the two waveforms establishes the limits of usefulness of the chopped mode compared to an alternately switched display or a dual-beam scope.

DIFFERENTIAL, BALANCED OR PUSH-PULL INPUTS

Push-pull signals may be introduced to the vertical deflection system if the input circuits are designed to accommodate such signals. Such amplifiers are commonly called differential or balanced amplifiers. They provide a feature beyond mere accommodation of push-pull signals: they have the ability to cancel or reject, to a high degree, any signal components equal in amplitude and phase that appear at both inputs. This ability explains the term "differential amplifier" since essentially only the difference between two signals is amplified. Such amplifiers provide a simple and accurate means of *measuring* the difference between two signals. They also provide a means of rejecting most of any unwanted signal components common to both inputs, such as power line "hum."

Please refer to the reference section on Non-Plug-In Oscilloscopes for a detailed explanation of differential measurements and noise considerations.

Oscilloscope measurements of voltages can be made with great accuracy using a differential comparator. A differential comparator consists of a differential input amplifier used in conjunction with an accurately calibrated adjustable-voltage source. When operating as a calibrated differential comparator or slide-back voltmeter the calibrated DC comparison voltage is internally applied, to differentially offset any unwanted portion of the applied signal; thereby allowing measurements of relatively small AC or DC signals riding on top of relatively large AC or DC signals. Differential comparator units may be used to make the following measurements: (1) measure DC voltages, (2) measure small AC or DC signals superimposed on DC, (3) measure small AC signal variations on large AC, and (4) measure high-amplitude low-frequency AC signals.

"SUMMING" INPUTS

A type of dual-input arrangement available on some amplifiers, opposite in character to differential input, is the summing input. Such an amplifier rejects *out-of-phase* signal components which are equal in amplitude but *adds* those components which are of the same phase. Since this amplifier adds or subtracts, depending on phase, a descriptive term is "added algebraically."

TRAVELING-WAVE AND DISTRIBUTED-DEFLECTION OSCILLOSCOPES

When examining extremely fast non-recurrent signals (or signals having a very low repetition rate) a high writing-rate oscilloscope having no vertical amplifier must be used. Ordinary cathode-ray tubes with only one pair of relatively long vertical deflection plates are not suitable in this type of scope because the transit-time of beam electrons through the deflection plate region is excessive and because the deflection plate capacitance and lead inductances tend to "ring." Traveling-wave and distributed-deflection cathode-ray tubes have numerous small vertical-deflection plates, connected to one another through a delay network, which progressively and collectively deflect the beam. An applied signal progresses from one plate to the next at the same speed as the beam electrons travel through the deflection region.

The principle features sacrificed in such instruments are usually vertical sensitivity and scan area. The term "sensibility" is sometimes used in preference to the terms "sensitivity" or "deflection factor." Sensibility is stated in terms of volts per spot diameter (or per trace width). When the deflection is quite small, sensibility is the better term since it accurately indicates the amount of information that can be contained in the scan area.

"SAMPLING" OSCILLOSCOPES

A very significant advancement in the art of oscilloscope design is a system employing sampling techniques. The technique is very similar, in principle, to the use of stroboscopic light to study fast mechanical motion. Progressive samples of adjacent portions of successive waveforms are taken; then they are "stretched" in time, amplified by relatively low-bandwidth amplifiers and finally shown, one sample at a time, on the screen of a cathode-ray tube. The graph produced is a replica of the sampled waveforms. The principle difference in appearance, between displays made by sampling techniques and conventional displays, is that those made by sampling are comprised of separate segments or dots. This technique is limited to depicting repetitive signals, since no more than one sample is taken and displayed each time the signal recurs.

The sampling method, however, provides a means for examining fast-changing signals of low amplitude that cannot be examined in any other way. The system is capable of resolving events that occur in less than 1 nanosecond, on an "equivalent" time-base of less than 1/5 nanosecond per cm and which have less than 10 mV of peak amplitude.

Basic sampling principles are covered in the Digital and Automated Systems Reference Section.

A recent innovation to sampling is the random sampler. The random sampler constructs a display of a repetitive waveform in a manner much like a conventional sampling oscilloscope but with a very significant difference for the user—no delay line or *pretrigger* is required for *lead time* in the display. The benefits thus afforded are numerous:

1. The inherent distortions and risetime limitation of bulky signal delay lines are eliminated.
2. It is no longer necessary to work into the 50-Ω characteristic impedance of a delay line.
3. Direct sampling probes may be used for convenient high-impedance, in-circuit signal pickup.
4. Triggers may occur prior to, coincident with, or AFTER the displayed signal without sacrificing lead time in the display.
5. Display jitter caused by pretrigger-to-signal jitter or by signal period uncertainty is eliminated.
6. Signals with no convenient source of pretrigger can be observed.

STORAGE OSCILLOSCOPES

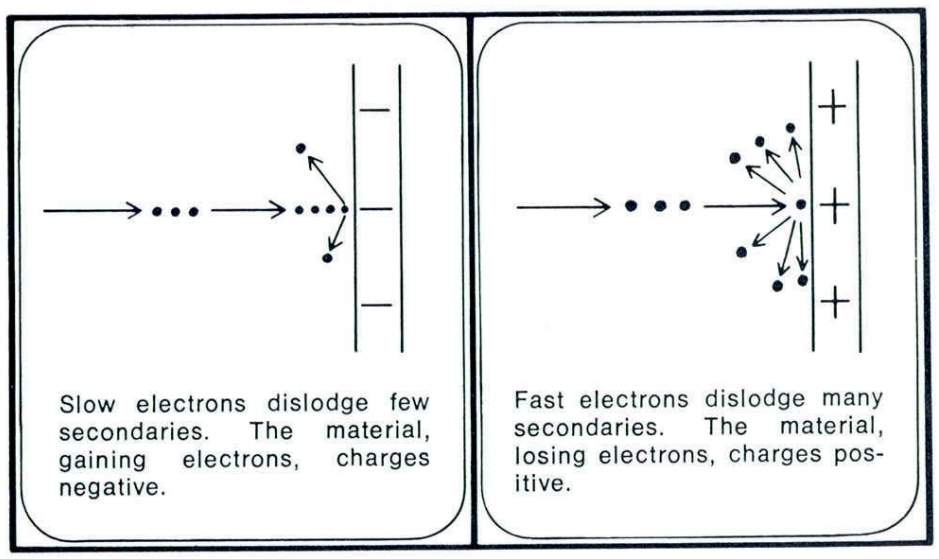
The freezing of a waveform in time by recording it on the storage oscilloscope screen until observed, or until a second event can be stored for direct comparison, has added unparalleled capability to oscilloscope instrumentation.

A storage oscilloscope has an ability to store a CRT display in order that it may be observed for any required time. This stored display may be instantly erased to make way for storage of a later event. By the flick of a switch, the instrument is converted to a normal display oscilloscope.

Storage oscilloscopes enable an engineer to make meaningful evaluations of slowly changing phenomena, that would appear not as a line but as a slow-moving dot on a conventional oscilloscope; and very rapidly changing "one-shot" events whose image would flash across the conventional oscilloscope screen too fast to be seen without elaborate camera equipment.

Historically, a limiting factor in adapting storage CRT's to oscilloscopes was the slowness of the storing mechanism in relation to the sweep velocities of general purpose scopes. New, faster responding storage CRT's are now available and, coupled with circuit methods which increase their speed of response, these obstacles have been overcome.

The Tektronix direct-view bistable storage tube (DVBST) is based on a secondary emission principle. When a stream of primary electrons strikes the phosphor target, secondary electrons are dislodged from the phosphor surface. As the potential increases, each primary electron displaces more than one secondary electron, resulting in the material charging positive.



Slow electrons dislodge few secondaries. The material, gaining electrons, charges negative.

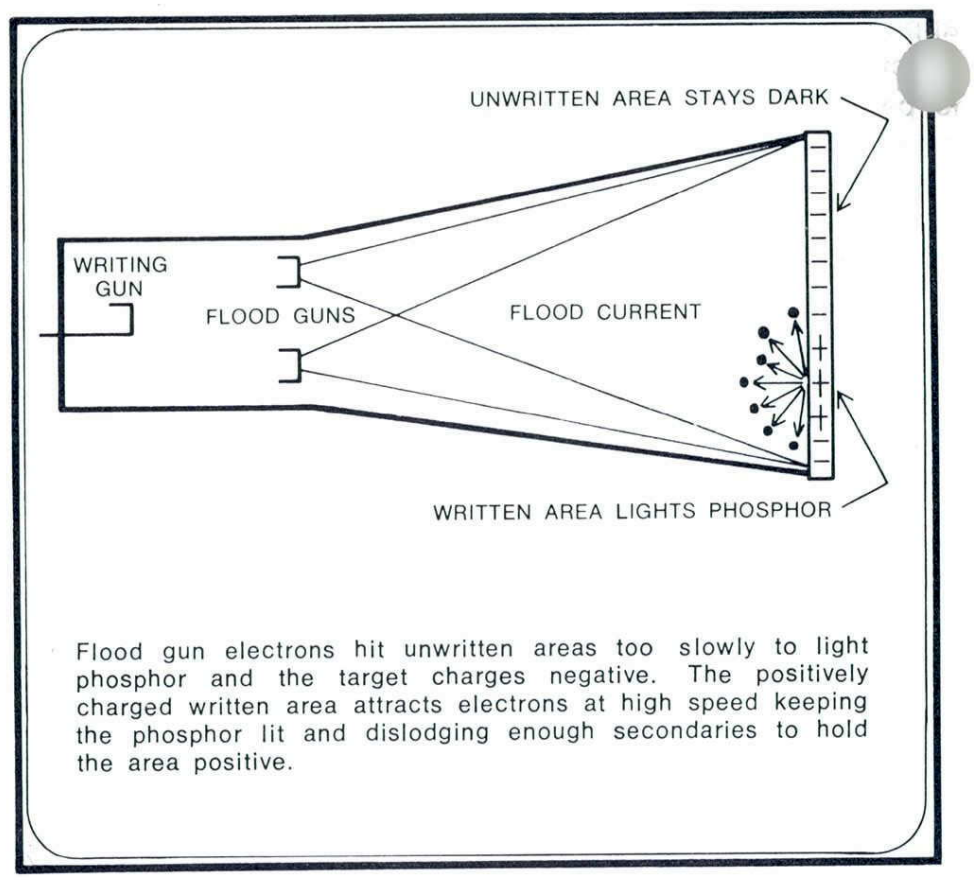
Fast electrons dislodge many secondaries. The material, losing electrons, charges positive.

In addition to the normal CRT writing guns, flood guns are used to cover the complete phosphor screen uniformly with low-velocity electrons. A conductive transparent face plate under the phosphor completes the circuit and allows storage to take place.

The normal writing gun bombards the phosphor screen with a beam of high-speed focused electrons. The beam writes and also dislodges great numbers of secondary electrons. The written surface where the waveform is traced out loses electrons and charges positive.

By using the flood-electron guns, the display may be stored. The flood guns emit low-velocity electrons over the whole CRT-screen area. The electrons strike the unwritten area too slowly to jar loose many secondaries. As a result, these areas merely collect electrons until they are driven negative and can attract no more current.

The latent image where the beam has written attracts flood electrons at such a velocity so each entering primary dislodges



Flood gun electrons hit unwritten areas too slowly to light phosphor and the target charges negative. The positively charged written area attracts electrons at high speed keeping the phosphor lit and dislodging enough secondaries to hold the area positive.

sufficient secondaries to hold the phosphor target positive. Thus, the written area neither gains nor looses electrons but remains positively charged and continues to attract flood current. As a result of this equilibrium, the trace is stored.

This is the basis for all Tektronix direct-view bistable storage tubes. The same flood current that holds the background dark also holds the written trace bright.

SPECTRUM ANALYZERS

Radio transmissions take various electronic configurations, ranging from single-frequency carriers to complex signals, produced by changing these carriers in amplitude, frequency and phase.

Regardless of the shape of these signals and how they were produced, or "modulated," each one can be separated into individual sinewaves. Each sinewave represents a single frequency. To examine the composition and quality of a signal, you would find it very helpful to extract each individual sinewave that it contains and display it alone on an oscilloscope. Seeing all the sinewaves in a "group" picture, each standing alone, would enable you to analyze the complex signal. The instrument that performs this task for you is called a Spectrum Analyzer.

Tektronix Spectrum Analyzers, built as plug-in accessories for existing oscilloscopes and as complete portable instruments, cover frequencies from 50 Hz to 40 GHz (Gigahertz).

For additional information please see section dedicated to Spectrum Analyzers.

(X-Y) OSCILLOSCOPES

Some scopes have vertical and horizontal amplifiers which are alike. In this way the two amplifiers can be made to have very similar characteristics. Perhaps the widest use of such instruments is for the plotting of two functions, such as current versus voltage, magnetizing force versus flux density, and speed versus acceleration. Another important use is the display of phase differences between two signals by means of Lissajous figures. Phase *equality* is particularly easy to verify by this means if the phase delay through each channel is the same at the frequency

applied. In most such instruments, phase shift does not remain ctly equal for all frequencies within the pass band—and this particularly true for frequencies near the upper limit of the pass band. Phase shift differences between the two amplifiers are especially apparent when the two amplifiers are not operated at equal deflection factors. If exacting phase comparisons or measurements at the higher frequencies need to be made by such instruments, some method is needed for first equalizing the phase shifts through the two amplifiers. The maximum phase difference at certain frequencies usually is specified, but often only for equal sensitivity settings.

CURVE TRACERS

Specific curve tracing oscilloscopes are built for displaying semiconductor parameters. Known as transistor curve tracers, these oscilloscopes are capable of displaying one or more characteristic curves of two and three-terminal devices.

By applying a constant voltage or current to an input terminal and sweeping the output terminal with a half sinewave of voltage, a single characteristic curve is generated. By applying a stair-step signal (step generator) to the input and sweeping the output terminal (collector supply) once for each successive step, up to 10 curves can be displayed. For maximum flexibility, the steps may be current or voltage, positive or negative, and offset by a positive or negative value of current or voltage.

Although the collector sweep is normally a rectified sinewave, it may consist of an unrectified sinewave (simultaneous monitoring of reverse breakdown and forward conduction), or a manually controllable DC potential (eliminates the trace loop- effect of the collector-to-base capacitance in low current ices).

The horizontal amplifier may select base volts and the vertical amplifier may select collector current or emitter current (high-gain leakage mode). Both amplifiers may select the step generator output.

A display amplifier with magnified offset capability provides display accuracies of up to 2% with either the horizontal or vertical amplifier.

The usual grounded emitter configuration for transistors normally displays collector voltage on the horizontal (or base volts) versus collector current at various drive levels. Grounded base configurations may also be displayed.

Curve Tracers are useful for diodes, tunnel diodes, zener diodes, SCR's, small signal and power transistors, FET's, MOSFET's, unijunctions, and other devices. Some of the advantages of curve tracing versus a DC point-by-point measurement are as follows:

1. Irregular characteristics are visible that may be overlooked on a point-by-point basis.
2. The device may be monitored over a wide range of operating conditions.
3. Dependence of one parameter upon another is clearly seen.
4. Changing magnitudes of 2 parameters can be observed simultaneously.
5. Characteristics are obtained quickly and easily.

Quick comparison capability—quick permanent record by photography.

PROBES

Tektronix has been engaged in an "across-the-measurement-spectrum" effort to develop probes that interface between the many varied signal sources and the vertical inputs of high-performance oscilloscopes. The success of this effort is best measured in the spectrum of Tektronix oscilloscopes/probe performance currently available to the oscilloscope user. This concept allows general-purpose oscilloscopes to adapt to many application areas that heretofore required additional plug-ins or special-purpose oscilloscopes.

Available probes include: DC current, AC current, high-speed differential, high voltage, sub-nanosecond active (FET), selectable attenuation, as well as high-speed miniature probes.

No single probe is best for all applications. It is still necessary for the user to determine the characteristics of his measuring circuit as closely as possible. Selection from the various probes available may then be made to minimize circuit loading for his measurement. Please refer to the probe section in this catalog for detailed specifications.

ENVIRONMENTAL CHARACTERISTICS

The environmental characteristics listed include some or all of the following:

Temperature, Altitude, Humidity, Vibration, Shock and Electromagnetic interference (EMI, previously RFI).

Sample production instruments are tested periodically as part of a continual quality control process. Complete tests on every production instrument are undesirable as well as uneconomical.

The specifications for humidity, vibration, shock and transportation are intended to be beyond what can be expected in use, and operation at these extremes may cause minor physical deterioration. Such operation, however, should not cause electrical performance deterioration outside specifications. The specifications for temperature and altitude are such that continual use at the limits will not cause significant short term deterioration. Naturally, higher temperature operation can be expected to reduce long-term reliability and should be avoided if possible. The EMI test is completely non-destructive.

For more specific information on the environmental characteristics and how they apply to given instruments, please refer to the page covering that instrument.

Reference Information

CATHODE-RAY TUBE PHOSPHOR DATA

The catalog description of each oscilloscope indicates the phosphor normally supplied. However, for specific applications, you may want to specify another phosphor.

Human Eye Response

An important factor in selecting a phosphor is the color or radiant energy distribution of the light output. The human eye responds in varying degrees to light wave length from deep red to violet. The human eye is peaked in its response in the yellow-green region and falls off on either side in the orange-yellow area and the blue-violet region. The eye is not very receptive to deep blue or red.

If the quantity of light falling on the eye is doubled, the brightness "seen" by the eye does *not* double. The brightness of a color tone as seen is approximately proportional to the log of energy of the stimulus.

The term *luminance* is the photometric equivalent of brightness and is based upon measurements made with a sensor having a spectral sensitivity curve corrected to that of the average human eye. The unit commonly used for luminance measurements is the foot lambert. The term *luminance* implies that data has been measured in a manner, or has been so corrected, to incorporate the CIE standard eye response curve for the human eye. CIE is an abbreviation for "Commission Internationale de l'Eclairage" (International Commission on Illumination). The luminance graphs and tables are therefore useful *only* when the phosphor is being *viewed visually*.

Phosphor Burning

When a phosphor is excited by an electron beam having an excessively high current density, a permanent loss of phosphor efficiency may occur. The light output of the damaged phosphor will be reduced and in extreme cases complete destruction of the phosphor may result. Darkening or burning occurs when the heat developed by electron bombardment cannot be dissipated rapidly enough by the phosphor.

The two most important and controllable factors affecting the occurrence of burning are *beam-current density* (controllable with the Intensity, Focus and Astigmatism controls) and the length of *time* the beam excites a given section of the phosphor (controllable with the Time/Div control). Under normal conditions in CRT's with grid unblanking, the quiescent voltage on the control grid will hold the tube in cutoff and no spot will be present on the screen.

The typical phosphor is about 10% efficient. This means that of the total energy from the beam, 90% is converted to heat and 10% to light. A phosphor must radiate the light and dissipate the heat; or as any other substance, it will burn. Remember, burning is a function of intensity and time. Keeping intensity down or the time short will save the screen.

For more specific information regarding the best-suited phosphor for your particular applications, please confer with your Tektronix Field Engineer, Representative or Distributor. He will know the factors that must be considered in selection of a phosphor for any given application. For example, P11 is excellent for waveform photography but due to its short persistence, it is not well suited for applications requiring visual observation of low speed phenomena.

Phosphors are rated in several parameters, such as color of fluorescence or phosphorescence, decay, etc. The following table describes the more commonly used phosphors.

PHOSPHOR DATA CHART

Phosphor	*Fluorescence*	*Phosphorescence Where Different Than Fluorescence*	*Relative Luminance*Ⓐ	*Relative Photographic Writing Speed*Ⓑ	*Decay to 0.1% (in ms)*	*Relative Burn Resistance*	*Comments*
P1	Yellowish-green	—	50%	20%	95	Medium	Replaced by P31 in most applications.
P2	Bluish-green	Yellowish-green	55%	40%	120*	Medium high	Good compromise for high and low speed applications.
P4	White	—	50%	40%	20	Medium high	Television displays
P7	Blue	Yellowish-green	35%	75%	1500*	Medium	Long decay, double layer screen.
P11	Purplish-blue	—	15%	100%	20	Medium	For photographic applications
P15	Bluish-green	—	15%	15%	0.05	Very high	Very short decay for flying spot scanner use.
P31	Yellowish-green	—	100%	50%	32	High	General purpose, brightest available phosphor.

Ⓐ Taken with a Spectra Brightness Spot Meter which incorporates a CIE standard eye filter. Representative of 10 kV aluminized screens. P31 as reference.

Ⓑ P11 as reference with Polaroid 410 film. Representative of 10 kV aluminized screens.

* Low level lasts over one minute under conditions of low ambient illumination.

Glossary of Terms

accelerating voltage—The cathode-to-[illegible]ving-area voltage applied to a cathode-ray tube for the purpose of accelerating the electron beam.

alternate display—A means of displaying output signals of two or more channels by switching the channels in sequence.

astigmatism—In the viewing plane of the cathode-ray tube, any deviation of the indicating spot from a circular shape.

attenuator—A device for reducing the amplitude of a signal without deliberately introducing distortion.

automatic triggering—A mode of triggering in which one or more of the triggering circuit controls are preset to conditions suitable for automatically displaying repetitive waveforms. The automatic mode may also provide a recurrent trigger or recurrent sweep in the absence of triggering signals.

bandwidth—Of an oscilloscope, the difference between the upper and lower frequency at which the voltage or current response is .707 (—3 dB) of the response at the reference frequency. Usually both upper and lower limit frequencies are specified rather than the difference between them. When only one number appears, it is taken as the upper limit.

[illegible]e 1: The reference frequency shall be (1) for the lower bandwidth limit, 20 times the limit frequency, and (2) for the upper bandwidth limit, 1/20 the limit frequency. The upper and lower reference frequencies are not required to be the same.

Note 2: This definition assumes the amplitude response to be essentially free of departures from a smooth roll-off characteristic.

Note 3: If the lower bandwith limit extends to DC, the response at DC shall be equal to the reference frequency, not —3 dB from it.

beam finder—A provision for locating the spot when it is not visible.

bezel—The flange or cover used for holding an external graticule or cathode-ray tube cover in front of the cathode-ray tube in an oscilloscope. May also be used for mounting a trace recording camera or other accessory item.

blanking—Extinguishing of the spot. Retrace blanking is the extinction of the spot during the retrace portion of the sweep waveform. The term does not necessarily imply blanking during the holdoff interval or while waiting for a trigger in a triggered sweep system.

[illegible]ghtness—The attribute of visual per[illegible]tion in accordance with which an area appears to emit more or less light.

chopped display—A time-sharing method of displaying output signals of two or more channels with a single cathode-ray tube gun, at a rate which is higher than, and not referenced to, the sweep rate.

chopping transient blanking—The process of blanking the indicating spot during the switching periods in chopped display operation.

common-mode signal—The instantaneous algebraic average of two signals applied to a balanced circuit, both signals referred to a common reference.

contrast—The comparative brightness between specified elements of a presentation.

conventional mode—That mode of operating a storage tube where the display does not store but performs with the usual phosphor luminance and decay.

deflection blanking—Blanking by means of a deflection structure in the cathode-ray tube electron gun which traps the electron beam inside the gun to extinguish the spot, permitting blanking during retrace and between sweeps regardless of intensity setting.

deflection factor—The ratio of the input signal amplitude to the resultant displacement of the indicating spot (for example, volts/division).

delay pickoff—A means of providing an output signal when a ramp has reached an amplitude corresponding to a certain length of time (delay interval) since the start of the ramp. The output signal may be in the form of a pulse, a gate, or simply amplification of that part of the ramp following the pickoff time.

delayed sweep—A sweep that has been delayed either by a predetermined period or by a period determined by an additional independent variable.

dual trace—A multi-trace operation in which a single beam in a cathode-ray tube is shared by two signal channels. See alternate display, chopped display and multi-trace.

edge lighting—A method of illuminating the lines on a graticule by introducing light into the edges of the graticule.

focus—Maximum convergence of the electron beam manifested by minimum spot size on the phosphor screen.

Gaussian response—A particular frequency response characteristic following the curve $y(f) = e^{-af^2}$. Typically, the frequency response approached by an amplifier having good transient response characteristics.

geometry—The degree to which a cathode-ray tube can accurately display a rectilinear pattern. Generally associated with properties of a cathode-ray tube; the name may be given to a cathode-ray tube electrode or its associated control.

graticule—A scale for measurement of quantities displayed on the cathode-ray tube of an oscilloscope.

input RC characteristics—The DC resistance and parallel capacitance to ground present at the input of an oscilloscope.

intensity—A term used to designate brightness or luminance of the spot.

intensity modulation—The process and (or) effect of varying the electron beam current in a cathode-ray tube resulting in varying brightness or luminance of the trace.

internal graticule—A graticule whose rulings are a permanent part of the inner surface of the cathode-ray tube faceplate.

jitter—An aberration of a repetitive display indicating instability of the signal or of the oscilloscope. May be random or periodic, and is usually associated with the time axis.

magnified sweep—A sweep whose time per division has been decreased by amplification of the sweep waveform rather than by changing the time constants used to generate it.

mixed sweep—In a system having both a delaying sweep and a delayed sweep, a means of displaying the delaying sweep to the point of delay pickoff and displaying the delayed sweep beyond that point.

multi-trace—A mode of operation in which a single beam in a cathode-ray tube is shared by two or more signal channels. See dual trace, alternate display and chopped display.

resolution—A measure of the total number of trace lines discernible along the coordinate axes, bounded by the extremities of the graticule or other specific limits.

risetime—In the display of a step function, the interval between the time at which the amplitude first reaches specified lower and upper limits. These limits shall be 10% and 90% of the nominal or final amplitude of the step, unless otherwise stated.

roll-off—A gradually increasing loss or attenuation with increase or decrease of frequency beyond the substantially flat portion of the amplitude-frequency response characteristic of a system or transducer.

signal delay—In an oscilloscope, the time required for a signal to be transmitted through a channel or portion of a channel. The time is always finite, may be undesired, or may be purposely introduced as in a delay line.

trigger—A pulse used to initiate some function (for example, a triggered sweep or delay ramp).

unblanking—Turning on of the cathode-ray-tube beam.

NEW

7000-Series Oscilloscope And Plug-In Reference

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SOME FACTORS AFFECTING THE VALUE OF THE NEW 7000-SERIES OSCILLOSCOPE SYSTEM

- A NEW THREE PLUG-IN OSCILLOSCOPE, TYPE 7503 - A FURTHER INDICATION OF THE EFFORT BEING DEVOTED TO EXPANDING THE 7000-SERIES OSCILLOSCOPE SYSTEM.
- NEW MEASUREMENT CAPABILITY ACROSS A BROADER PERFORMANCE SPECTRUM.
- AUTO SCALE-FACTOR READOUT.
- ADVANCED PHOTOGRAPHIC TRACE-RECORDING CAPABILITIES.
- A NEW CONCEPT IN PLUG-IN AND MAINFRAME VERSATILITY.
- VERTICAL AND HORIZONTAL MODE SWITCHING.
- EXPANDED TRIGGER SOURCE SELECTION.
- PEAK-TO-PEAK AUTO TRIGGERING.
- SINGLE-ACTION LIGHTED PUSH-BUTTON CONTROLS.
- COLOR-KEYED CONTROL PANELS.
- LOW TORQUE CAM SWITCHES.
- THICK FILM DRUM ATTENUATORS.

INTRODUCTION

Throughout its history of product development, Tektronix has sought to safeguard the customer's investment. The Tektronix 7000-Series Oscilloscopes illustrate the major effort which has been devoted to achieving this goal. The first of these instruments offered initial performance in excess of other general-purpose plug-in oscilloscopes—plus the capability of expanding into new uses. The introduction of the New three plug-in Type 7503 Oscilloscope and the New 7B52 Time Base further supports the emphasis which is placed upon performance, compatibility and flexibility in the 7000-Series Oscilloscope System.

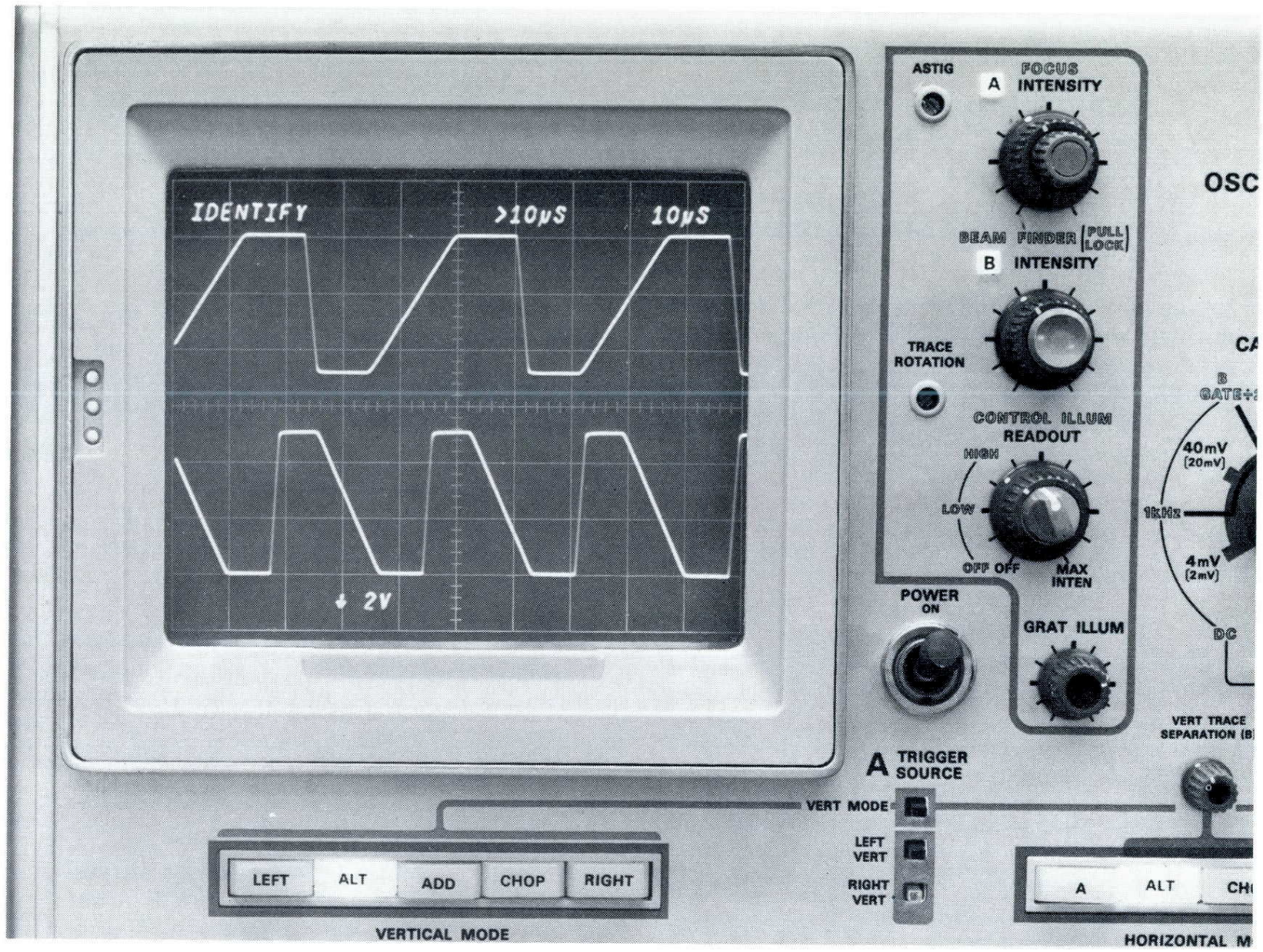
In addition to advances in performance, convenience, and flexibility, the 7000-Series Oscilloscopes offer advances in other significant areas. New components have been designed which overcome many restrictions and limitations of previous devices. The human engineering devoted to the front panel optimizes ease of operation in an instrument versatile enough to meet the needs of increasingly complex measurement requirements. Auto Scale-Factor Readout contributes significantly to increased operator convenience in today's oscilloscope and will prove to be a major factor for expanding future measurement flexibility. The NEW 7000-Series Oscilloscope System has been analyzed, designed, and developed to guard against obsolescence. Some of the factors affecting the value of these oscilloscopes are discussed on the following pages.

AUTO SCALE FACTOR READOUT

The CRT is the focal point of any oscilloscope and this is particularly true of these instruments. The CRT of the New 7000 Series displays the analog waveform and an alpha-numeric readout of the vertical and horizontal deflection factors. The advantages of Scale-Factor Readout may be grouped into three general categories: (1) by displaying measurement information on the CRT, it relieves the user of many of the simple, but time consuming motions and interruptions normally associated with waveform measurement, (2) it eliminates many of the errors frequently made in waveform measurements, and (3) in anticipation of the requirements of expanding technologies, it provides the user with the future capability of displaying, on the CRT, measurement information in areas not now fully defined or developed.

NEW

7000-Series Oscilloscope And Plug-In Reference



The following examples are typical of the questions which must be answered during a measurement procedure. What is the vertical deflection factor? What is the horizontal deflection factor? Is a horizontal magnifier in use? Is a 10X probe is use? Is either trace inverted? Are any vertical or horizontal controls in an uncalibrated mode? What is a feasible way of recording pertinent information on photographs? With Auto Scale-Factor Readout, these questions and others are answered on the CRT. Thus, time and effort are saved, and errors are reduced.

The readout sequence is from left to right in the same order as the plug-in channels: LEFT, RIGHT, A, and B. If a single channel plug-in is used the readout appears at the top of the CRT; the second channel of a dual-channel unit would appear in a corresponding position at the bottom of the CRT. A trace IDENTIFY push button on each amplifier unit deflects the appropriate trace and identifies the correct readout.

A NEW CRT

The new cathode-ray tube is a single-beam, 5-inch rectangular display device. The internal, parallax-free graticule is 8 div x 10 div (each div is one cm) with variable illumination. Three independent intensity controls adjust trace brightness for A SWEEP, B SWEEP, and READOUT. A two-position BEAM FINDER will limit deflection within the display area and insure a visible trace.

The CRT is operated at 24 kV in the 7704 and 18 kV in the 7504 and 7503 for improved visual and photographic writing speed. The photographic writing speed is specified at 3300 cm/μs in the 7704 and 2250 cm/μs in the 7504 and 7503, with the standard P31 phosphor. The writing speeds are measured with the C-51 Camera, 10,000 ASA Polaroid* film without film fogging techniques. The lens in the C-51 is an f/1.2; 1:0.5 object-to-image ratio.

*Registered Trademark Polaroid Corporation

PLUG-IN FLEXIBILITY

Plug-in capability, a theory in instrumentation when first introduced by Tektronix, was validated by immediate customer acceptance. The beginning was a single plug-in oscilloscope; several years ago the dual plug-in oscilloscope was introduced. Both concepts represented a mark of achievement in instrumentation. But, in anticipation of future user needs and expected technological breakthroughs, a new concept was formulated—the four-plug-in oscilloscope. The four-plug-in oscilloscope will prove to be a valuable contribution to your measurement flexibility.

Currently, there are 14 plug-in units available for the 7000-Series mainframes: 6 amplifiers, 5 time-base units, 2 sampling units, and a high-quality plug-in delay line. The versatility of the system lies in these building block combinations which allow a more concise matching of instrument to application.

Amplifier Plug-Ins

AMPLIFIERS	MIN DEFL FACTOR	PERFORMANCE FEATURED	BANDWIDTH	
			7704	7503/7504
7A11	5 mV/div	Low-capacitance FET Probe Amplifier	150 MHz	90 MHz
7A12	5 mV/div	Dual-channel Amplifier	105 MHz	75 MHz
7A13	1 mV/div	Differential DC Offset, High-Freq CMRR Amplifier	100 MHz	75 MHz
7A14	1 mA/div	AC Current Probe Amplifier (2 current probes)	50 MHz 105 MHz	45 MHz 75 MHz
7A16	5 mV/div	Wide-bandwidth Conventional Input Amplifier	150 MHz	90 MHz
7A22	10 μV/div	DC-Coupled, High-Gain Differential Amplifier	1 MHz	

NEW

7000-Series Oscilloscope And Plug-In Reference

Combinations

Single Trace—Any single-channel amplifier operating as the only vertical plug-in. A blank plug-in panel is available to cover any unfilled plug-in compartment.

Dual Trace—A single 7A12, or any two single-channel amplifiers utilizing the internal amplifier switching (ALT or CHOP). The two units can be the same or mixed to offer different input configurations.

Three Trace—A dual-channel 7A12 using its own switching capability matched with a single-channel amplifier.

Four Trace—Two dual-channel 7A12's using both plug-in and internal amplifier switching.

X-Y Operation—The amplifiers will operate in vertical or horizontal channels, providing for X-Y operation. The internal amplifier switching presents dual X-Y display with four amplifier units, or X-Y, Y-T display with three amplifiers and a time-base unit.

Time-Base Plug-Ins

There are two time-base units available for each four plug-in 7000-Series mainframe. The differences between the plug-ins are the maximum sweep speeds available and the triggering frequency range they are designed to cover. The units for each mainframe are essentially identical, and can be used separately or in combination which provides for DELAYING SWEEP operation. The 7B52, with Intensified, Mixed and Delayed Sweep Modes, is compatible with all 7000-Series Oscilloscopes. It is designed especially for the Type 7503 which has one horizontal plug-in compartment.

TIME-BASE	MAIN-FRAME	FUNCTION	MAX SWEEP RATE	TRIGGERING FREQ RANGE
7B71	7704	Delaying Sweep	2 ns/div	DC - 200 MHz
7B70		Delayed Sweep & Ext Amplifier		
7B51	7504	Delaying Sweep	5 ns/div	DC - 100 MHz
7B50		Delayed Sweep & Ext Amplifier		
7B52	7503	Delayed & Mixed Sweeps	5 ns/div	DC - 100 MHz

SAMPLING UNITS

The 7S11 SAMPLING UNIT, 7M11 DELAY LINE, and 7T11 SAMPLING TIME BASE are the building blocks for utilizing the Sampling technique with the 7000-Series mainframes. In conjunction with the five plug-in sampling heads and the mainframe switching capability, they offer an extremely versatile combination of operational modes.

The 7S11 accepts a PLUG-IN HEAD which determines the frequency response (to 14 GHz) and input configuration. The 7S11 also controls DEFLECTION FACTOR, DOT RESPONSE, and DC OFFSET functions.

The 7T11 is the sampling time base. It features 10 ps/div to 5 ms/div calibrated sweep rates and random or sequential operations. To cover that wide range of TIME/DIV settings, the 7T11 automatically crosses from EQUIVALENT time to REAL time displays at an appropriate sweep range. The triggering range of the unit is from $\simeq$ 10 Hz to above 12.4 GHz which precludes the requirement for an internal trigger countdown unit.

The 7M11 is a dual 75-ns delay line and pretrigger source necessary for viewing the triggering event in the sequential sampling mode of operation. For most applications above 1-kHz repetition rate, the random mode can be used which requires no pretrigger or delay line.

Combinations

Single Trace—One 7S11, one 7T11 with the 7M11 optional depending on the application. There are direct interconnections between the 7S11 and 7T11 requiring the units to be adjacent in the mainframe. In the four plug-in oscilloscopes the 7S11 would occupy the RIGHT vertical channel and the 7T11 the A horizontal channel; the 7M11 can occupy an unused plug-in compartment for convenience.

Dual Trace—Two 7S11's can be used with a single time base for time-related displays utilizing the internal vertical switching. The direct interconnections necessary between the LEFT vertical and the time base passes through the RIGHT channel 7S11.

X-Y Sampling—Two 7S11's mounted in RIGHT vertical and the adjacent horizontal compartment automatically adopt a common 50-kHz free-running strobe condition for X-Y displays.

Single-Trace Sampling and Single-Trace Real Time—A pair of sampling plug-ins (vertical and horizontal) and a pair of real-time plug-ins can be used simultaneously for convenience in applications which require frequent use of both types of displays. This is a capability of the four plug-in oscilloscopes.

X-Y COMPENSATION OPTION

(Applies to 7704 and 7504 Only)

For X-Y applications which require precise phase measurement, the horizontal mainframe amplifiers can be equipped with a network which compensates for the difference between vertical and horizontal signal delay. With correction, the phase shift between vertical and horizontal can be adjusted to be less than 2° from DC to 2 MHz. Without the compensation network, phase shift is 2° or less from DC to 35 kHz.

VERTICAL AND HORIZONTAL MODE SWITCHING

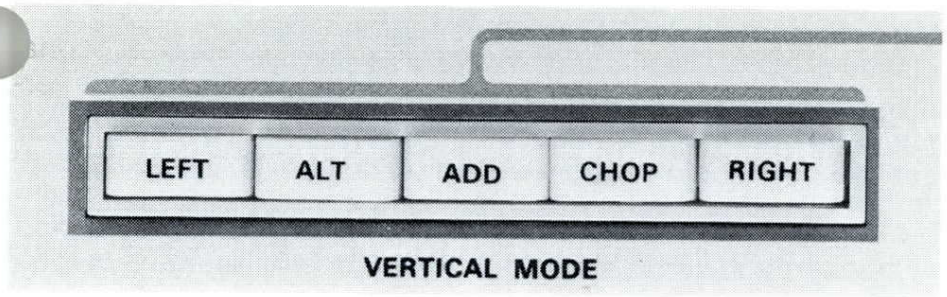
By electronically switching between vertical and horizontal plug-ins, the 7000-Series four plug-in mainframe provides measurement options which are not available in any other single beam oscilloscope. In the past, a second or third vertical plug-in was not always usable in combination with another plug-in in a single-beam oscilloscope. Now, different kinds of plug-ins may be used simultaneously in a single mainframe. To realize the maximum benefits from this new option, the user needs electronic plug-in switching at his disposal; the mainframe is the logical place for this switching to be done. Vertical and horizontal switching in the New 7000-Series mainframes provide 20 possible combinations of operating modes in the four plug-in oscilloscopes. A wide selection of multi-trace options is provided even in applications where performance parameters vary considerably. Thus, the user can select the two vertical plug-ins most appropriate for his measurement, and still have multi-trace performance.

A second important benefit of vertical and horizontal mode switching in the mainframe is the simulation of dual-beam capabilities. Many users have found themselves faced with having to purchase a true dual-beam oscilloscope for applications where horizontal chopping or alternating between two time bases would have solved the measurement problem. The 7000-Series horizontal mode switching provides this capability. It is another of the many new features which have been included in the mainframe to make the system as nearly complete as possible to reduce the customer's total instrument cost.

NEW

7000-Series Oscilloscope And Plug-In Reference

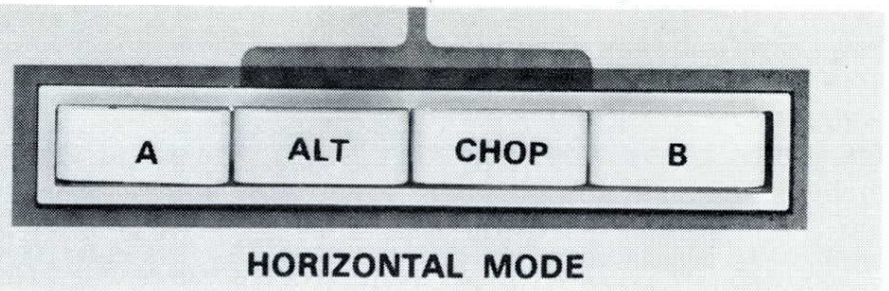
Vertical Switching Modes



VERTICAL MODE

Both vertical and horizontal deflection amplifiers are "dual-trace" with two separate plug-in inputs. Electronic switching in either ALTERNATE or CHOP MODES time-share the CRT beam between channels. The two left-side plug-in channels are labeled LEFT vertical and RIGHT vertical. The MODE is push-button selected as LEFT only, ALT, ADD, CHOP, RIGHT only. Any pair of 7000-Series plug-ins can operate as a vertical combination. Bandwidth, sensitivity, and signal input characteristics are plug-in dependent, as outlined in the System Specification chart.

7704 and 7504 Horizontal Switching Modes



HORIZONTAL MODE

The two right-side plug-in channels are labeled A (left) and B (right). The horizontal MODE is push-button selected as A only, ALT, CHOP, B only. Any pair of 7000-Series plug-ins will operate as a horizontal combination.

Horizontal Switching Logic

The ALT vertical and ALT or CHOP horizontal MODE combination is a "slaved" operation. RIGHT vertical information will be displayed only by A sweep; LEFT vertical information by B sweep. The result, effectively, is a "dual-beam" type of display as it relates to independent control of deflection factors, position and intensity.

The chart briefly shows 20 possible combinations of vertical and horizontal operating MODES.

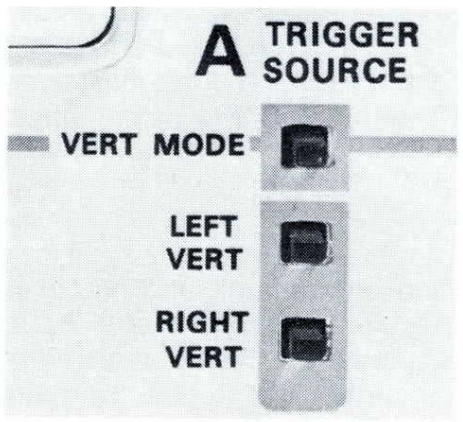
VERT MODE	HORIZ MODE	DISPLAY
LEFT	A, B	Single-trace
	ALT, CHOP	(A) independent dual time base (B) simultaneous DELAYING and DELAYED-sweep display
ALT	A, B	Dual-trace
	ALT, CHOP	(A) independent "dual-beam" display (B) X-Y, X-Y display (CHOP ONLY) (C) X-Y, Y-T display (D) "dual-trace" delaying-sweep display
ADD	A, ALT, CHOP, B	Algebraic addition of vertical channels with: (A) single-trace (B) dual time base (C) "dual-trace" delaying-sweep display
CHOP	A, B	Dual-trace
	ALT, CHOP	"dual-trace" delaying-sweep display
RIGHT	A, B	Same display capability as with LEFT above
	ALT, CHOP	

TRIGGERING

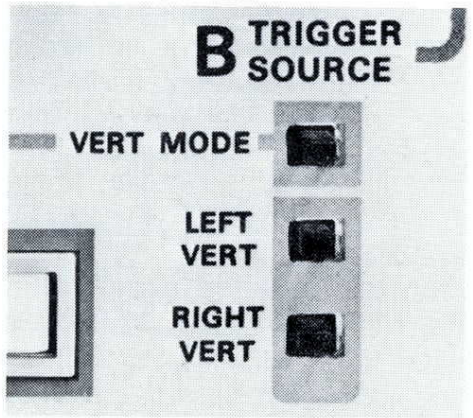
Triggering in the 7000-Series Oscilloscopes is improved by the New Peak-to-Peak Auto triggering mode and expanded internal trigger selection from vertical plug-ins and the mainframe. The New Peak-to-Peak Auto Mode provides stable, hands-off triggering for many applications. Even an inexperienced oscilloscope user will find triggering to be as simple as pressing three push-button controls: INT, AC and P-P AUTO. With P-P Auto triggering, a bright baseline is provided at all sweep speeds in the absence of a signal. When a signal of 0.5 div or greater is present, a triggered sweep is obtained throughout the 360° range of the Level/Slope control.

There will be times, of course, when the measurement will require different triggering modes. In anticipation of these requirements, the New 7000 Series is designed with a wide range of mainframe and plug-in trigger selection options. Mainframe trigger selection options include the VERT MODE, LEFT VERT, and RIGHT VERT modes. Both the A and B time-base trigger signal can be selected individually from either of these sources. To compete the selection options, the trigger signal may be selected from Channel 1 or 2, or a composite of Channels 1 and 2, in multi-trace plug-ins. All trigger source controls are color-keyed for ease of operational understanding.

INTERNAL TRIGGER SELECTION



7000 Series



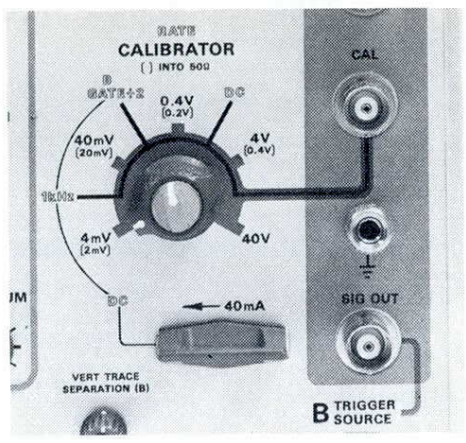
7704 - 7504 ONLY

The trigger signal to the time base is selected by lighted push-button switches for LEFT, RIGHT, or VERT MODE. The vertical signal from both LEFT and RIGHT plug-ins is coupled through the trigger logic circuitry and made available to the time-base units for triggering purposes, and to a SIGNAL OUT jack for external use. The VERT MODE eliminates the need to continually select the trigger source. Activating the VERT MODE trigger switch slaves the trigger signal source to the displayed signal in the LEFT VERT, RIGHT VERT and ALT position of the VERTICAL MODE display switch. In the ADD or CHOP positions of the VERTICAL MODE display switch, the internal trigger signal is the algebraic sum of the signals applied to the vertical plug-ins. This prevents the time base from triggering on the chopped signal.

NEW

7000-Series Oscilloscope And Plug-In Reference

CALIBRATOR



The multi-function CALIBRATOR supplies accurate time, voltage, and current source for GAIN check and adjustment of all 7000-Series plug-ins. Amplitude accuracy is within 1% and time accuracy (1 kHz) within 0.5%, sufficient to be used as the standard for most system specifications. The 5 open-circuit voltage levels are available as DC, or AC at 1 kHz, or AC at a rate triggered by every other B GATE output of the 7704 and 7504 and GATE output of the 7503. The voltage output into 50 Ω is also indicated. Current amplitude through the loop is 40 mA DC or AC at the selected rate.

OUTPUTS

+Sawtooth—1 V per horizontal division of deflection into 1 MΩ. Internally selectable from A or B sweep on the dual time base 7704 and 7504.

+Gate—Rectangular pulse, 10 V into 1 MΩ. Internally selectable from A or B sweep on the dual time base 7704 and 7504.

Sig Out—Vertical signal determined by TRIGGER SOURCE, at 0.5 V per vertical division of deflection.

Camera Power—Three-prong connector to the left of the CRT provides power, ground, and remote single sweep reset access for the C-50 and C-51 Cameras.

LIGHTED PUSH BUTTONS

Versatility in a waveform measurement system imposes stringent demands upon human engineering. For example, if an instrument is to have advanced versatility and remain functional, it must have switches, controls and panels designed to optimize the user-instrument interface. It is evident that the New 7000-Series Oscilloscopes are designed such that they are easily operated even with more controls at the user's disposal.

Single-action push-button switches have been used extensively to conserve front panel space. The most obvious advantage of this is the reduction of operator inconvenience which close proximity of controls normally causes. All push-button switches are lighted for identification ease and protrude approximately 5 mm from the front panel to eliminate any interference between push-button switches and other controls.

VARIABLE CONTROLS

The controls for uncalibrating the instrument and varying the deflection factors and sweep speeds are recessed flush with their associated calibrated controls until placed into use. When pressed, the variable control unlatches from its recessed position, protrudes for easy access, and uncalibrates the related control. The sides of the variable controls are colored red to indicate that the instrument is in an uncalibrated mode. When the variable mode is no longer needed, the knob is pressed into the latched position, the red disappears and the instrument is calibrated again.

COLOR-KEYED PANELS

The potential usefulness of a general purpose instrument would be destroyed if its versatility becomes such that the user does not understand its operation. Tektronix recognized the challenge of building a versatile instrument whose operation would be straight forward enough so that the user, with a minimum amount of effort, could benefit from the complete advantages of its measurement capabilities. The human engineering devoted to the color-keyed front panel clearly illustrates that the response to this challenge is successful.

The functions of the front panel controls have been identified by background color codes. There are four primary colors: red, blue, green, and gray.

Red—used for the nomenclature and controls that will uncalibrate the instrument.

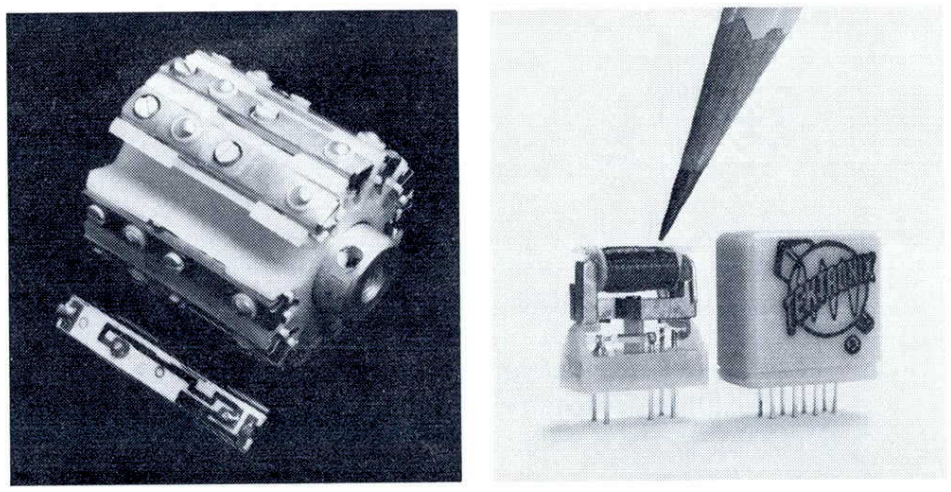
Blue—identifies controls affecting the CRT display mode.

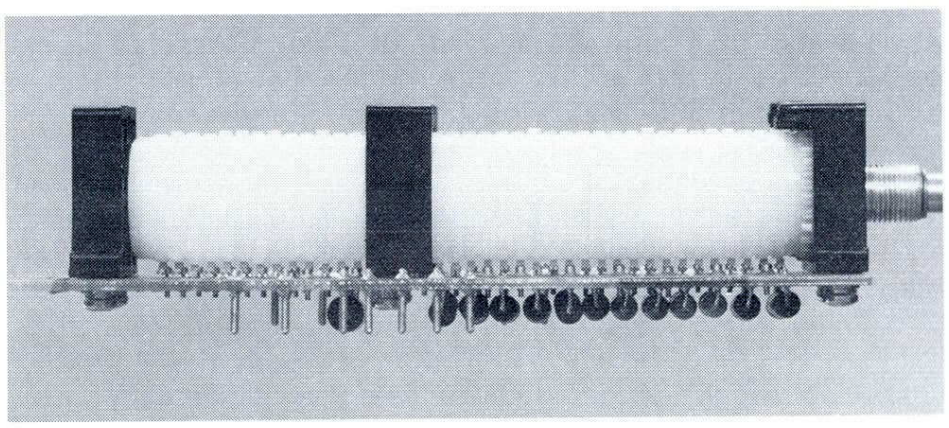
Green—identifies all trigger controls.

Gray—has no functional meaning, used to group or combine certain controls such as CRT beam controls.

ELECTRO-MECHANICAL CONSIDERATIONS

The increased measurement capabilities of the 7000-Series instruments have placed previously unencountered demands upon electro-mechanical design. Many of the capabilities of this new series of oscilloscopes would not have been possible without advances in mechanical designs. Wafer type switches and conventional attenuators impose definite limitations upon instrument design. To overcome these limitations, Tektronix has designed and incorporated into these instruments new low torque cam switches to reduce wiring problems, increase switch life, reduce congestion, and to improve maintenance and ease of operation. Conventional attenuators are replaced in the 7A16 vertical amplifier by new drum type attenuators which have the RC network mounted upon a drum. Replacing an RC network is as simple as replacing a plug-in transistor. The new Tektronix instruments make extensive use of relays and relay switching. These low-capacitance miniature sensitive relays have less leakage than semiconductor switches and are much more tolerant of transient voltage considerations.





Some of the Tektronix components used in new generation instruments. Clockwise from upper left: thick-film drum attenuator, miniature relay, rotary cam switch.

NEW

7704

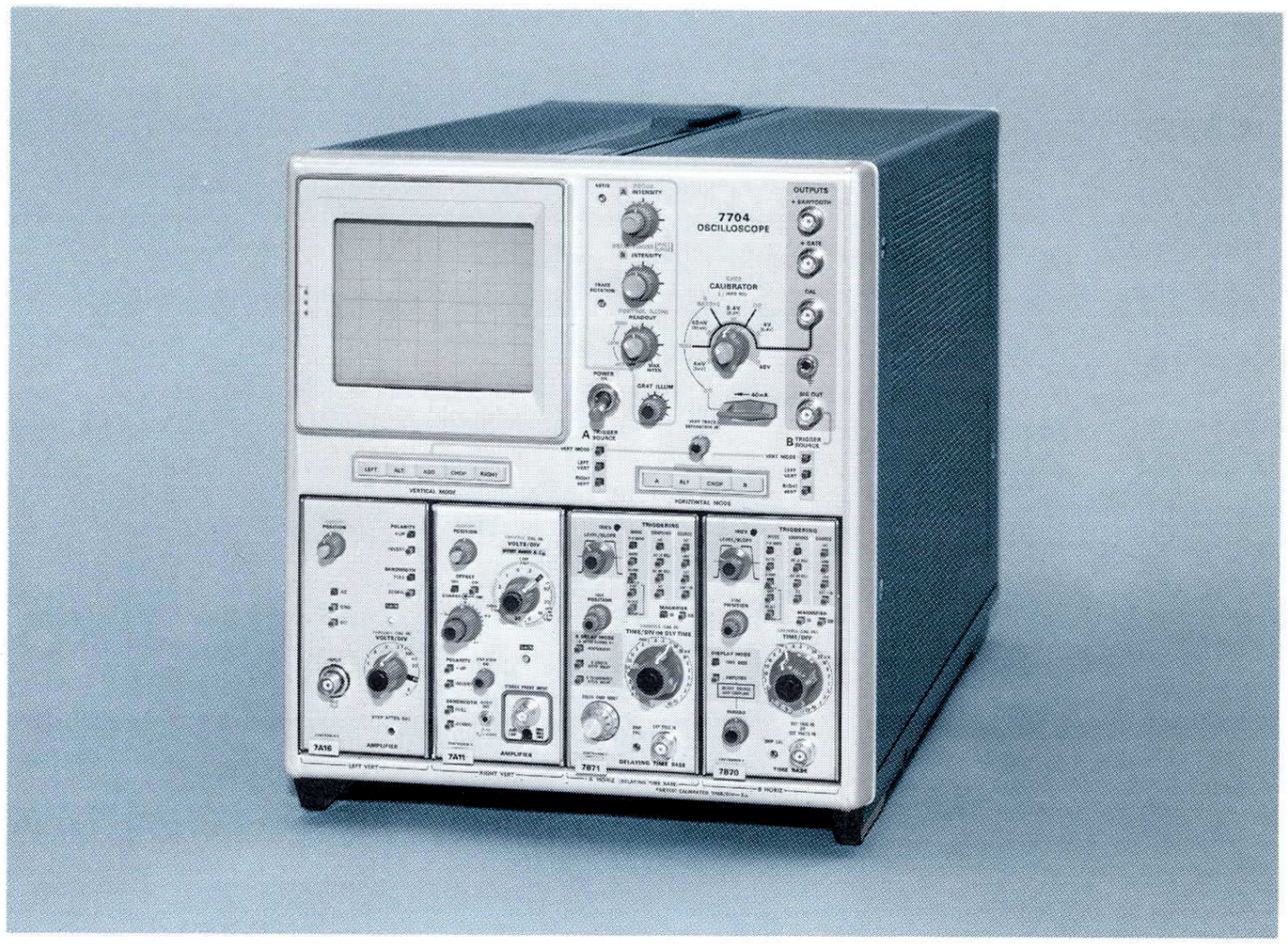
Oscilloscope Mainframe

NEW

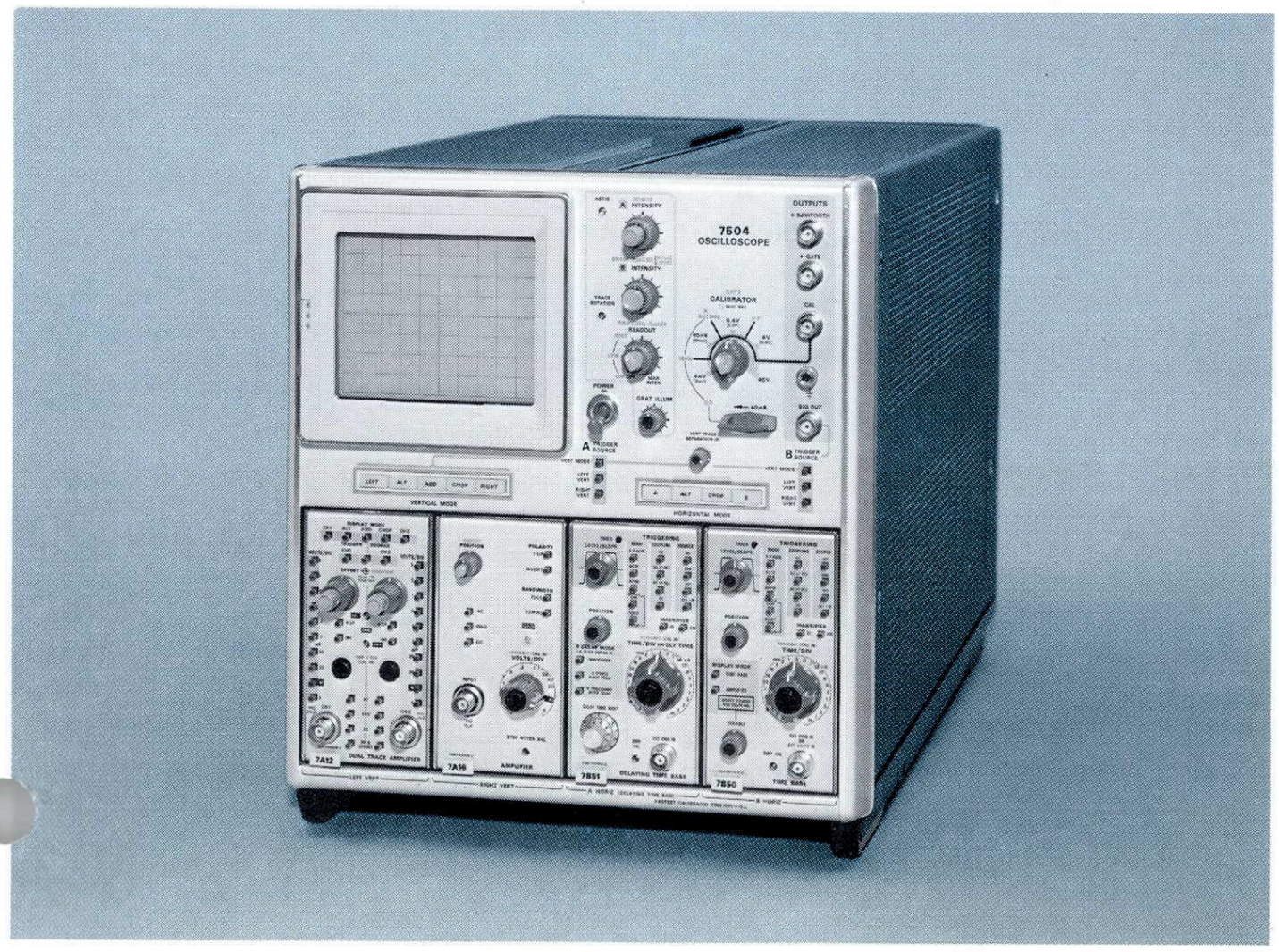
7504

FEATURES OF BOTH OSCILLOSCOPES

- FOUR PLUG-IN FLEXIBILITY
- 8 x 10 cm DISPLAY AREA
- AUTO SCALE-FACTOR READOUT
- VERSATILE TRIGGER SOURCE SELECTION
- VERTICAL AND HORIZONTAL MODE SWITCHING
- PUSH-BUTTON SWITCHING CONTROLS.
- COLOR-KEYED PANELS
- HIGH WRITING SPEED CRT



7704
DC to 150 MHz
OSCILLOSCOPE



7504
DC to 90 MHz
OSCILLOSCOPE

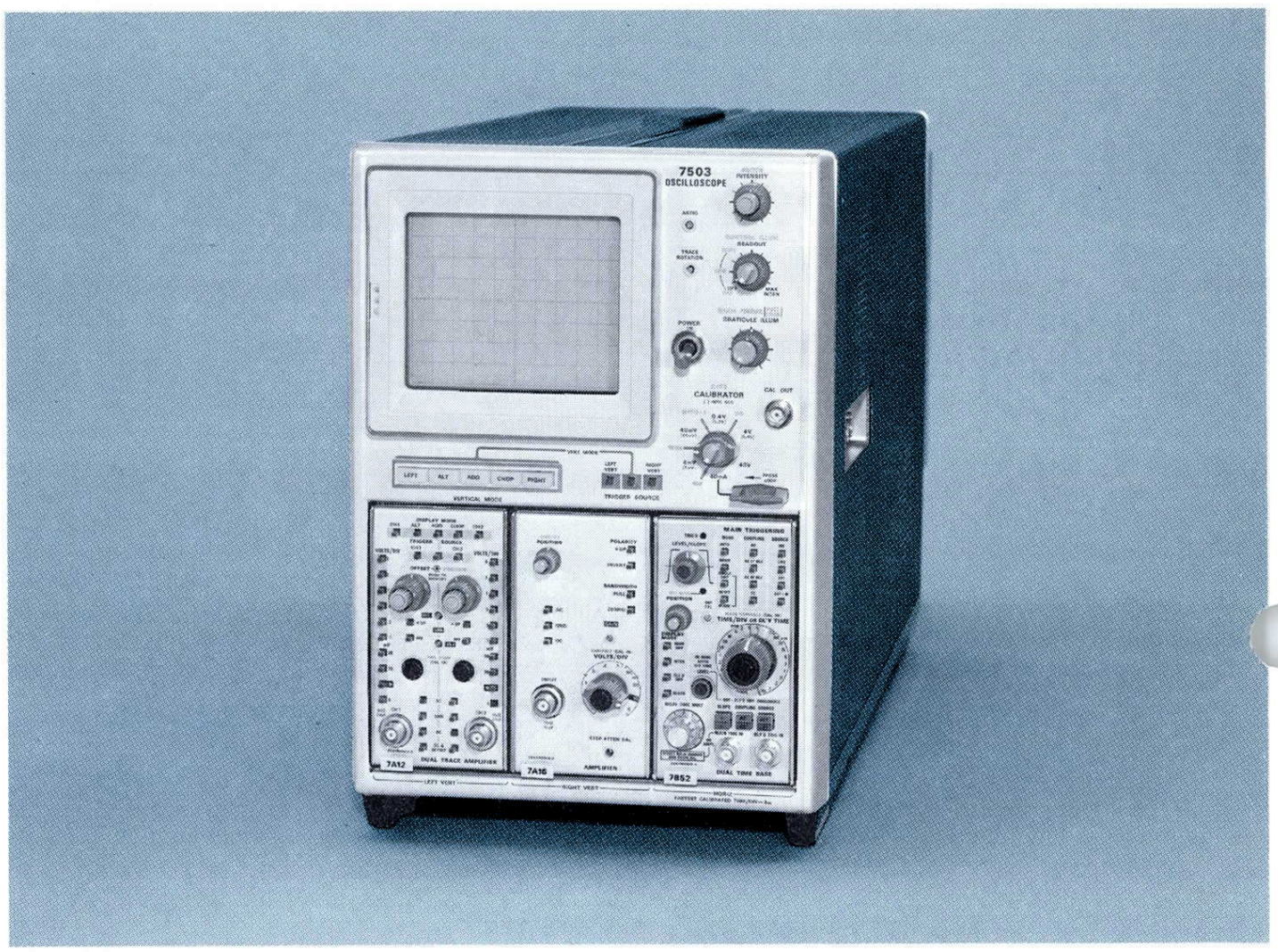
NEW

7503 Oscilloscope Mainframe

7503

- THREE PLUG-IN FLEXIBILITY
- 8 x 10 cm DISPLAY AREA
- AUTO SCALE-FACTOR READOUT
- VERSATILE TRIGGER SOURCE SELECTION
- VERTICAL MODE SWITCHING
- COLOR-KEYED PANELS
- PUSH-BUTTON SWITCHING
- HIGH WRITING SPEED CRT

7503
DC to 90 MHz
OSCILLOSCOPE



7704, 7504, and 7503

SYSTEM SPECIFICATIONS

Plug-In Unit	Probe	Vertical System								Horizontal System BW	
		7704 (8-cm reference)		7504 - 7503 (8-cm reference)		Accuracy		INT CAL 0° to 50°C	SIG OUT BW	With Phase Compensation	
		BW	T_r	BW	T_r	EXT CAL 0° to 50°C	INT CAL 15° to 35°C			7704	7504-7503
7A11	Integral	150 MHz	2.4 ns	90 MHz	3.9 ns	2%	3%	4%	60 MHz	3 MHz	2 MHz
7A12	None	105 MHz	3.4 ns	75 MHz	4.7 ns	2%	3%	4%	55 MHz	3 MHz	2 MHz
	P6053	105 MHz	3.4 ns	75 MHz	4.7 ns	3%	4%	5%	55 MHz	3 MHz	2 MHz
7A13	None	100 MHz	3.4 ns	75 MHz	4.7 ns	1 1/2%	2 1/2%	3 1/2%	55 MHz	3 MHz	2 MHz
	P6053	100 MHz	3.4 ns	75 MHz	4.7 ns	1 1/2%	2 1/2%	3 1/2%	55 MHz	3 MHz	2 MHz
7A14	P6021	50 MHz	7.0 ns	45 MHz	7.8 ns	2%	3%	4%	40 MHz	3 MHz	2 MHz
	P6022	105 MHz	3.4 ns	75 MHz	4.7 ns	2%	3%	4%	50 MHz	3 MHz	2 MHz
7A16	None	150 MHz	2.4 ns	90 MHz	3.9 ns	2%	3%	4%	60 MHz	3 MHz	2 MHz
	P6053	150 MHz	2.4 ns	90 MHz	3.9 ns	3%	4%	5%	60 MHz	3 MHz	2 MHz
7A22	None or Any	1 MHz	350 ns	1.0 MHz	350 ns	2%	3%	4%	1.0 MHz	800 kHz	800 kHz

System Environmental Specification

Temperature Range — 0° to +50°, operating.
Altitude — Operating to 15,000 feet; nonoperating to 50,000 feet.

NEW 7704

NEW 7504

NEW 7503

SPECIFICATIONS

Specifications are common to each unit unless noted.

VERTICAL SYSTEM

Channels—Two left-hand plug-in compartments; compatible with all 7000-Series plug-ins.

Deflection Factor—Determined by plug-in unit.

Bandwidth—Determined by mainframe and plug-in unit. See System Specification Chart.

Chopped Mode—1-MHz repetition rate within 20%.

Trace Separation Range (7704 and 7504 dual-sweep modes)—The B trace can be positioned at least 4 div; 4 div to 6 div down from the A trace.

HORIZONTAL SYSTEM

Channels—7704 and 7504, two right-hand plug-in compartments; compatible with all 7000-Series plug-ins. 7503, one right-hand plug-in compartment; compatible with all 7000-Series plug-ins.

Fastest Calibrated Sweep Rate

7704—2 ns/div with the 7B71 and/or 7B70

7504—5 ns/div with the 7B51 and/or 7B50

7503—5 ns/div with the 7B52

Chopped Mode—Chopping rate is 200 kHz within 20% between two horizontal plug-in compartments of the 7704 and 7504.

X-Y Mode—PHASE SHIFT is within 2° from DC to 35 kHz between vertical and horizontal channels. Frequency Response at 10% down is DC to at least 3 MHz (7704); or 5 MHz (7504 and 7503).

CALIBRATOR

Output Wave Shape—Rectangular, positive-going from ground.

Voltage Ranges

Open Circuit— 4 mV, 40 mV, 0.4 V, 4 V, 40 V.

Into 50 Ω— 2 mV, 20 mV, 0.2 V, 0.4 V.

Current Output (Loop)—40 mA DC or 40 mA signal, waveshape determined by RATE SWITCH.

Amplitude Accuracy—Within 1% (+15°C to +35°C); within 2% (0°C to 50°C) for both voltage and current.

Sources—DC; 1 kHz accurate within 0.5%, duty cycle is 50%, accurate within 0.1%; GATE ÷ 2 frequency determined by every other GATE pulse.

Risetime and Falltime— <0.25 μs for all ranges except +40 V which is <2 μs with 10-pF load.

EXTERNAL Z-AXIS INPUTS

HIGH SENSITIVITY INPUT

Minimum Pulse Width to Blank Trace:
7704—30 ns at 2 V.
7504—40 ns at 2 V.
7503—40 ns at 2 V.

Sensitivity—2 V P-P for full intensity range from DC to 2 MHz, intensity range diminishes at 10 MHz to an equivalent 0.4 V DC input.

Polarity—Positive signal blanks trace.

Input R—500 Ω within 10%.

Max Input Voltage—15 V (DC + peak AC)

HIGH SPEED INPUT

Minimum Pulse Width to Blank Trace:
7704—3.5 ns at 60 V.
7504—5 ns at 60 V.
7503—5 ns at 60 V.

Sensitivity—60 V P-P for full intensity range.

Polarity—Positive signal blanks trace.

Frequency Range—7704, DC to 100 MHz
7504, DC to 75 MHz
7503, DC to 75 MHz

Input R—18 kΩ within 20%.
Max Input Voltage—60 V (DC + peak AC). AC component limited to 60 V P-P.

OUTPUTS

+SAWTOOTH

Sawtooth starts 1 V or less from ground (into 1 MΩ). Internally selectable from A or B horizontal on oscilloscopes with two horizontal channels.

Output Voltage—50 mV/div (±15%) into 50 Ω
1 V/div (±10%) into 1 MΩ

Output R—950 Ω within 2%

+GATE

7704 and 7504, positive-going rectangular waveform derived from A, B, or DELAYED gate, internally selectable.

7503, positive pulse of the same duration and coincident with sweep.

Output Voltage—0.5 V (±10%) into 50 Ω
10 V (±10%) into 1 MΩ

Risetime—20 ns or less into 50 Ω

Output R—950 Ω within 2%

SIG OUT

7704 and 7504, selected by B TRIGGER SOURCE switch.
7503, selected by TRIGGER SOURCE switch.

Output Voltage—25 mV/div (±10%) into 50 Ω.
0.5 V/div (±10%) into 1 MΩ.

Bandwidth—Depends upon vertical plug-in. See Systems Specifications.

Output Resistance—950 Ω within 2%.

NEW

7704

NEW

7504

NEW

7503

CRT

Accelerating Potential—7704 - 24 kV
7504 - 18 kV
7503 - 18 kV

Graticule—Internal 8 cm x 10 cm with variable illumination.

Phosphor—P31 standard; P1, P2, P7, P11 optional at no additional cost.

Photographic Writing Speed—Measured without film fogging; with standard P31 phosphor.

Mainframe	Writing Speed	Camera	Lens	Film
7704	3300 cm/μs	C-51	f/1.2 1:0.5	10,000 ASA
	2200 cm/μs	C-27	f/1.3 1:0.5	
7504 and 7503	2250 cm/μs	C-51	f/1.2 1:0.5	10,000 ASA
	1500 cm/μs	C-27	f/1.3 1:0.5	

Beam Finder—Limits display within graticule area.

POWER REQUIREMENTS

Power Connection—Each instrument is designed for operation from a power source with its neutral at or near ground (earth) potential. It is not intended for operation from two phases of a multi-phase system, or across the legs of a single-phase, three-wire system. It is provided with a three-wire power cord with a three-terminal polarized plug for connection to the power source. The third wire is directly connected to the instrument frame, and is intended to ground the instrument to protect operating personnel, as recommended by national and international safety codes.

Line Voltage Ranges

	7704	7504 - 7503
115 V	90 VAC to 136 VAC	Low — 90 VAC to 110 VAC Med — 104 VAC to 126 VAC High — 112 VAC to 136 VAC
230 V	180 VAC to 272 VAC	Low — 180 VAC to 220 VAC Med — 208 VAC to 252 VAC High — 224 VAC to 272 VAC

Line Frequency—48 Hz to 440 Hz

Max Power Consumption

7704, 210 Watts, 2.6 Amps at 115 V line, 60 Hz.
7504, 280 Watts, 3.2 Amps at 115 V line, 60 Hz.
7503, 258 Watts, 3.0 Amps at 115 V line, 60 Hz.

DIMENSIONS AND WEIGHTS

	7704		7504		7503	
Height	in	cm	in	cm	in	cm
	13.5	34.2	13.5	34.2	13.5	34.2
Width	12	30.5	12	30.5	9.2	23.4
Length	23.3	59.0	24.6	62.2	24.6	62.2
Net wt	lb	kg	lb	kg	lb	kg
	42	19	54	24.2	53	24

INCLUDED STANDARD ACCESSORIES

OPTIONS 1 and 2
Two instruction manuals 7704, (070-0981-00); two instruction manuals 7504, (070-0932-00); two instruction manuals 7503, (070-1039-00); BNC-post jack (012-0092-00); two 18-inch patch cord BNC-BNC (012-0087-00); 9-pin connector, male insert (134-0049-00); 3-to-2 wire adapter (103-0013-00).

OPTION 3
EMI modified instruments include the above accessories plus the following: mask (426-0514-00); light filter (378-0625-00).

7704 OSCILLOSCOPE **$2500**
7504 OSCILLOSCOPE **$2000**
7503 OSCILLOSCOPE **$1775**

INSTRUMENT OPTIONS

OPTION 1

Readout Modification
The instruments may be ordered without AUTO SCALE FACTOR READOUT by specifying "Option 1". This deletes the character generator circuitry contained on a single plug-on printed circuit card. The feature may be easily added at any time by ordering the conversion kit.

7704 OSCILLOSCOPE Without Readout, Option 1 .... **$2100**
7504 OSCILLOSCOPE Without Readout, Option 1 .... **$1600**
7503 OSCILLOSCOPE Without Readout, Option 1 .... **$1375**
READOUT CONVERSION KIT (040-0533-00) ..... **$ 400**

OPTION 2

APPLIES TO 7704 and 7504 ONLY

X-Y Horizontal Compensation
A compensation network may be added to equalize the signal delay between the vertical and horizontal amplifiers. When included, the phase shift between vertical and horizontal channels is adjustable to less than 2° from DC to 2 MHz. The option may be included at the time of purchase, or added later with the field conversion kit.

X-Y HORIZONTAL COMPENSATION, Option 2 .... **Add $ 75**
7504 CONVERSION KIT (040-0528-00) ..... **$ 75**
7704 CONVERSION KIT (040-0529-00) ..... **$ 75**

OPTION 3

Electromagnetic Interference (EMI) Modification
The instruments may be ordered to meet the interference specifications of MIL-I-6181D over the following frequency ranges: Radiated from the instrument under test—150 kHz to 1 GHz; conducted through the power cord—150 kHz to 25 MHz. A field conversion kit is available to convert an instrument whenever necessary.

EMI MODIFICATION, Option 3 ..... **Add $ 75**
7704 or 7504 EMI CONVERSION KIT (040-0527-00) .. **$100**
7503 EMI CONVERSION KIT (040-0547-00) **$100**

Blank Plug-In Panel
When operating the 7000-Series instruments with less than the full complement of plug-ins, the blank plug-in panel may be used to cover unused channels.

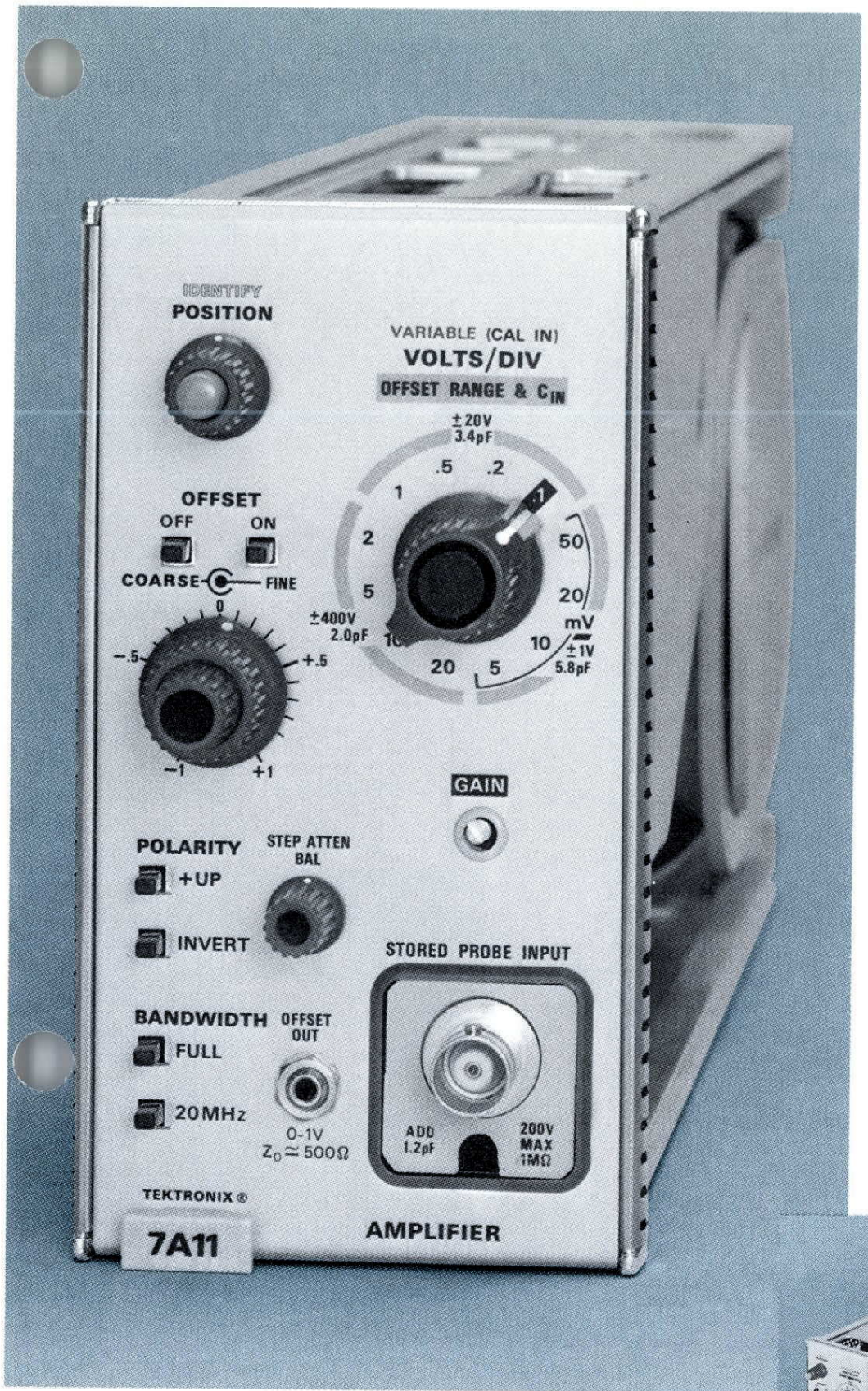
7000-SERIES BLANK PLUG-IN PANEL (016-0155-00) ... **$6**

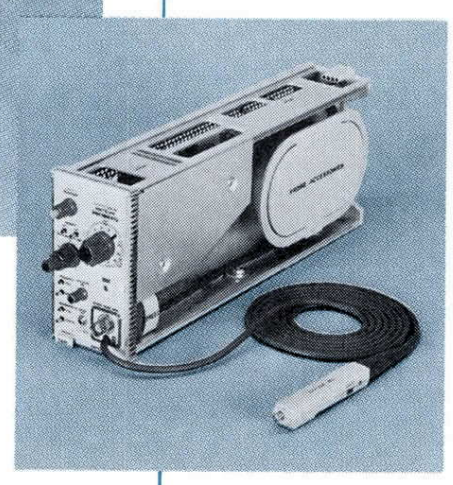
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

FET Probe/Amplifier

7A11

NEW





DESCRIPTION

The 7A11 is a wideband plug-in amplifier for the 7000-Series mainframes. The captive FET probe input configuration optimizes signal acquisition with high resistance (1 MΩ) and low capacitance (5.8 pF max at 5 mV/div) without loss of signal amplitude by probe attenuation. With large amplitude signals it is necessary in any amplifier to insert attenuation before the input stage to keep the signal extremes on-screen. The 7A11 probe has two 20X attenuators, physically mounted in the probe tip, that are relay-switched into the input signal path at the appropriate deflection factor. This frees the operator from concern with manual plug-on attenuators and dynamic signal range. If signal can be positioned or offset to fall within the viewing area, the amplifier is operating linearly.

Other operational features include: trace IDENTIFY, which moves the trace up slightly and identifies the appropriate Auto Scale Factor Readout area; DC OFFSET with an accurate monitor output; and internal probe storage with BNC input for convenience in less demanding applications.

SPECIFICATIONS

DEFLECTION FACTOR

5 mV/div to 20 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 2% of GAIN adjustment at 0.1 V/div. The uncalibrated VARIABLE is continuous between steps.

BANDWIDTH

FULL BANDWIDTH Mode

Mainframe	Bandwidth —3 dB	Risetime
7704	150 MHz	2.4 ns
7504	90 MHz	3.9 ns
7503	90 MHz	3.9 ns

20 MHz BANDWIDTH Mode—DC to 20 MHz within 2 MHz.

AC COUPLED INPUT—15 Hz or less (low frequency —3 dB point).

INPUT R and C

RESISTANCE—1 MΩ within 1%.

CAPACITANCE—
5.8 pF within 0.6 pF from 5 mV to 50 mV/div.
3.4 pF within 0.4 pF from 0.1 V to 1 V/div.
2.0 pF within 0.2 pF from 2 V to 20 V/div.

MAX INPUT VOLTAGE

DC COUPLED—200 V (DC + peak AC); AC component derated above 10 MHz.

AC COUPLED—200 V DC.

MAX INPUT GATE CURRENT

≤0.25 nA at 25°C; ≤1.2 nA at 50°C.

DC DRIFT

DRIFT WITH TIME (constant ambient temperature and line voltage).
SHORT TERM: 0.1 div or less per minute after 20-minute warm-up.
LONG TERM: 0.3 div or less per hour after 20-minute warm-up.

DRIFT WITH AMBIENT TEMPERATURE (constant line voltage) 200 μV/°C.

DISPLAYED NOISE

1 mV or 0.2 div, whichever is greater, in FULL BANDWIDTH mode, measured tangentially.

OFFSET FUNCTION

An internal DC SOURCE, continuously variable between +1 V and —1 V, which may be used to offset the trace. (See chart for OFFSET RANGE.) An OFFSET OUT Jack allows monitoring of the offset voltage. OFFSET OUT source resistance is 500 Ω within 3%.

V/DIV	OFFSET RANGE	OFFSET RANGE TO OFFSET OUT
5 mV to 50 mV/div	+1 V to —1 V	1:1 within 1% +0.5 mV
0.1 V to 1 V/div	+20 V to —20 V	20:1 within 1.5% +0.5 mV
2 V to 20 V/div	+400 V to —400 V	400:1 within 2% +0.5 mV

INCLUDED STANDARD ACCESSORIES

Two instruction manuals (070-0984-00); one AC coupler (011-0110-00); one retractable hook tip (013-0106-00); one bayonet ground (013-0085-00); one ground lead (nose), 3 inch (175-0849-00); one ground lead (screw-in) 3 inch (175-0848-00); one ground lead (screw-in), 12 inch (175-0848-02); three minigator clips (344-0046-00); two insulating tubes (166-0404-01); one hook tip (206-0114-00); GR/PROBE adapter termination (50 Ω) (017-0088-00). One 18 inch Offset Out cable (175-1092-00).

7A11 FET PROBE/AMPLIFIER $850

U.S. Sales Prices FOB Beaverton, Oregon

Please refer to Terms and Shipment, General Information page.

NEW

7A16 Amplifier 7A16

SPECIFICATIONS

DEFLECTION FACTOR

5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence). Accuracy is within 2% with GAIN adjusted at 10 mV/div. Uncalibrated VARIABLE is continuous between steps.

BANDWIDTH

FULL BANDWIDTH Mode

Mainframe	Bandwidth —3 dB	Risetime
7704	150 MHz	2.4 ns
7504	90 MHz	3.9 ns
7503	90 MHz	3.9 ns

20 MHz BANDWIDTH Mode—DC to 20 MHz within 3 MHz.

AC COUPLED—10 Hz or less (lower —3 dB bandwidth).

INPUT R and C

1 MΩ within 2%; 15 pF within 0.5 pF.

MAX INPUT VOLTAGE

DC COUPLED—500 V (DC + peak AC), AC component of 1 kHz or less.

AC COUPLED—500 V DC.

MAX INPUT GATE CURRENT

0.1 nA or less 0°C to +35°C.
3.0 nA or less +35°C to +50°C.

DC DRIFT

DRIFT WITH TIME (ambient temperature constant).

SHORT TERM—250 μV/min P-P or 0.05 div whichever is greater, 1 hour after turn-on.

LONG TERM—250 μV/hr P-P or 0.05 div whichever is greater, 1 hour after turn-on.

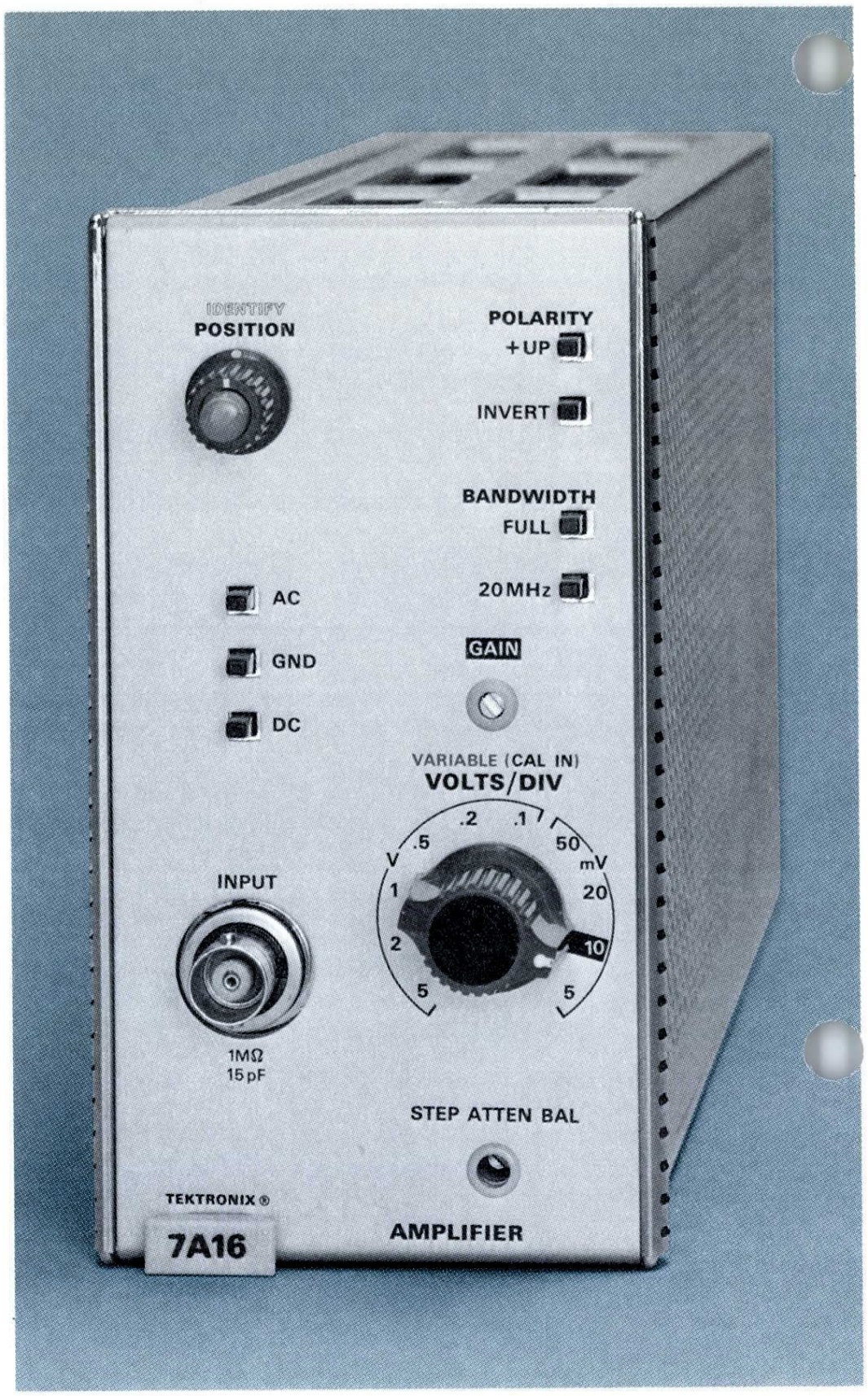
DRIFT WITH AMBIENT TEMPERATURE—100 μV/°C or less.

INCLUDED STANDARD ACCESSORIES

Two instruction manuals (070-0980-00).

7A16 AMPLIFIER **$600**

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.



DESCRIPTION

The 7A16 is a wideband plug-in amplifier for the 7000-Series mainframes. It features constant bandwidth (150 MHz in the 7704, 90 MHz in the 7504 and 7503) over the deflection factor range of 5 mV/div to 5 V/div. Polarity of the display is selectable, as is bandwidth, which can be either FULL or limited to 20 MHz for low frequency applications. The 7A16 should be considered as half the vertical capability. The two mainframe channels allow the 7A16 to be used alone, or with another single-trace vertical unit for dual-trace operation. The 7A16 can also be used in the horizontal channels for X-Y operation.

PROBES

The P6053 (10X) probe is recommended for use with the 7A16 for frequency response and Auto Scale Factor Readout compatibility.

Dual-Channel Amplifier

NEW
7A12

SPECIFICATIONS

DEFLECTION FACTOR

5 mV/div to 5 V/div in 10 calibrated push-button steps (1-2-5 sequence). Accuracy is within 2% with GAIN adjusted at 10 mV/div. Uncalibrated VARIABLE is continuous between steps.

BANDWIDTH

Mainframe	Bandwidth —3 dB	Risetime
7704	105 MHz	3.4 ns
7504	75 MHz	4.7 ns
7503	75 MHz	4.7 ns

AC COUPLED—10 Hz or less (lower —3 dB point).

INPUT R and C

1 MΩ within 2%; 24 pF within 1 pF for all deflection factors.

MAX INPUT VOLTAGE

DC COUPLED—500 V (DC + peak AC at 1 kHz or less).

AC COUPLED—500 V DC.

MAX INPUT GATE CURRENT

≤0.2 nA from 0°C to 35°C; 3.2 nA from 35°C to 50°C.

DC DRIFT

With ambient temperature 100 μV/°C or 0.1 div or less, whichever is greater.

DC OFFSET RANGE

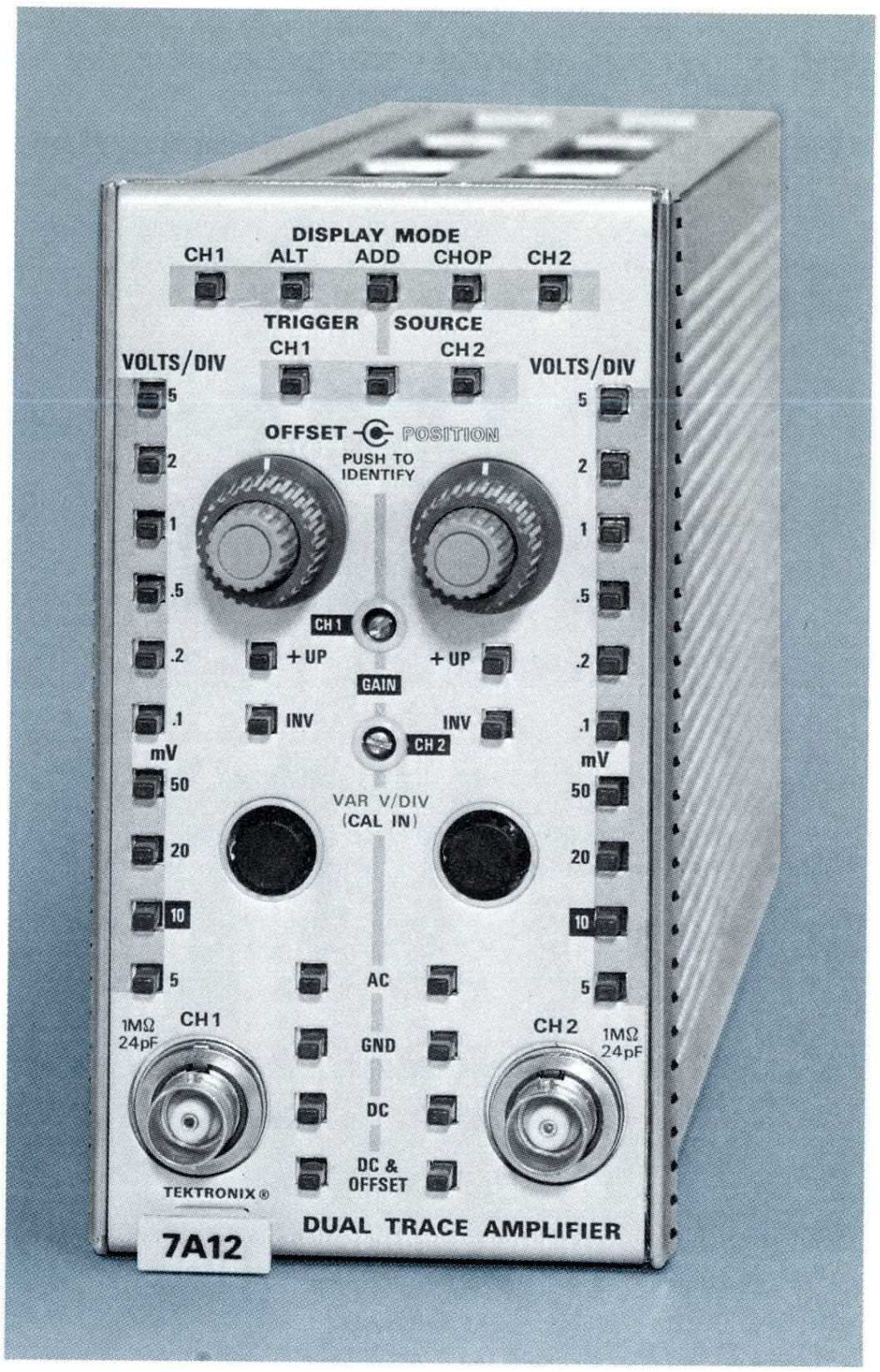
At least +1000 div to —1000 div at 5 mV/div.
At least +500 div to —500 div at 10 mV/div to 5 V/div.

INCLUDED STANDARD ACCESSORIES

Two instruction manuals 070-0977-00.

7A12 DUAL-CHANNEL AMPLIFIER $700

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.



DESCRIPTION

The 7A12 is a dual-channel plug-in amplifier for use with the 7000-Series mainframes. It is the basic building block for 3 or 4 trace operation. It features constant bandwidth for all deflection factors, 5 operating modes, trigger source selectivity, trace OFFSET with ±1000 div range, color-keyed control grouping, and a trace IDENTIFY function.

The high density of controls on a 2 5/8 inch by 5 inch front panel was made possible, and very usable, by the development and use of lighted push buttons for all except continuously variable functions. The switches conserve space both in front and behind the panel, provide faster operation (direct steps to any position) and easy readability by backlighting.

NEW

7A14 Current Probe Amplifier 7A14

DESCRIPTION

The 7A14 is an AC current probe amplifier for the 7000-Series mainframes. It provides constant bandwidth, dependent on the current probe and mainframe over the 1 mA/div to 1 A/div calibrated deflection factors (see bandwidth specifications). POLARITY is selectable, +UP or INVERT, as is BANDWIDTH, FULL or 20 MHz.

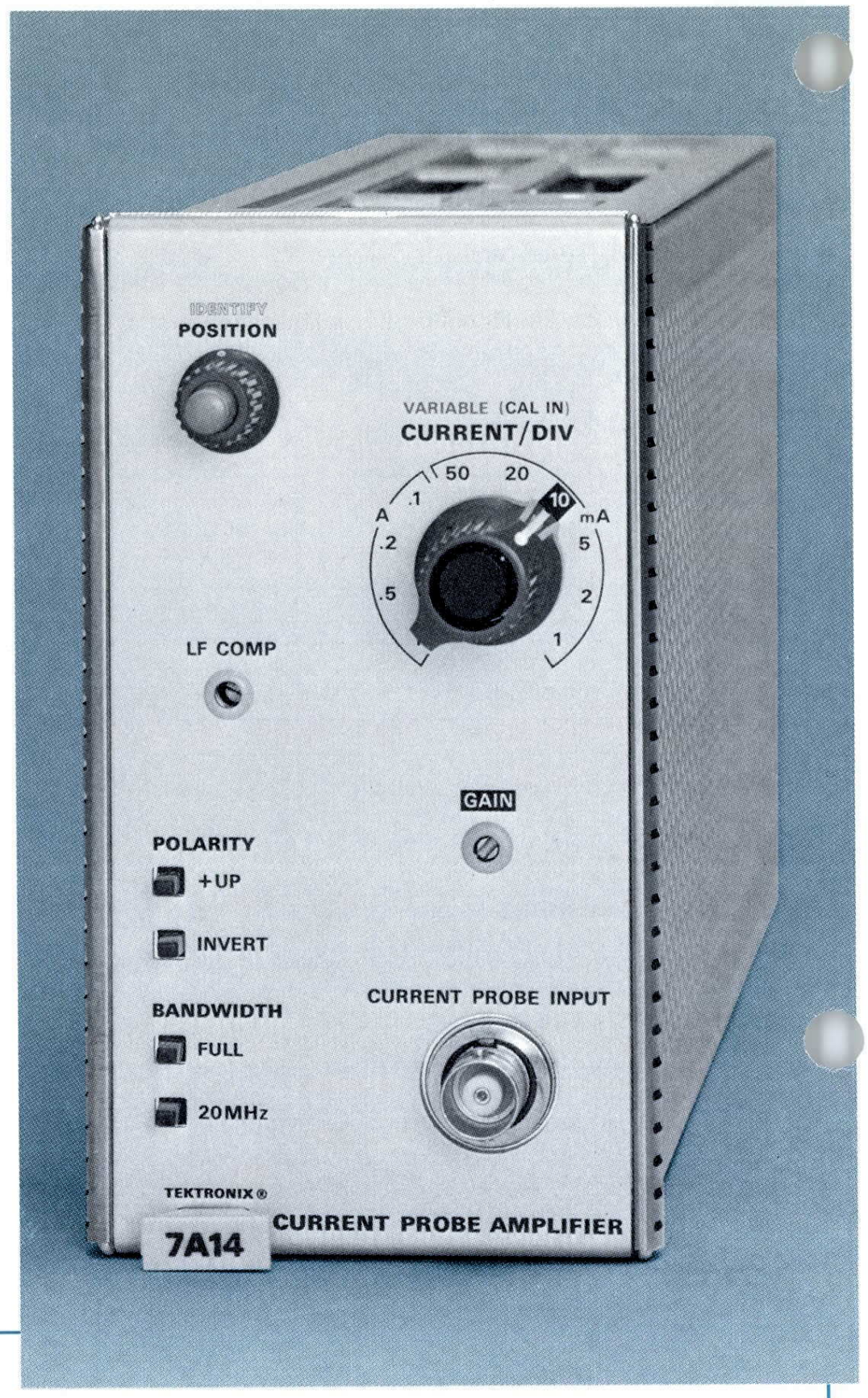
PROBES

The P6021 and P6022 AC current probes are designed for use with the 7A14. The probes can be interchanged without gain adjustment due to the special BNC input connector which senses the type of probe and switches internal compensation circuits. Both probes are the quick-connect, locking-jaw type.

P6021—optimized for low-frequency response. The probe/amplifier lower —3 dB point is 30 Hz or less. The upper —3 dB point is 45 MHz and 50 MHz in the 7500 and 7700 mainframes, respectively.

P6022—designed for high-frequency response. The upper —3 dB point is 75 MHz and 105 MHz in the 7500 and 7700 mainframes respectively. Lower frequency —3 dB frequency is 250 Hz or less.

Probes are not supplied with the 7A14 and are ordered separately to fit the application.



SPECIFICATIONS

DEFLECTION FACTOR

1 mA to 1 A/div in 10 calibrated steps (1-2-5 sequence). Accuracy is within 2% with GAIN adjusted at 10 mA/div. The VARIABLE Control provides variable deflection factors between steps, extends deflection factor to at least 2.5 A/div.

BANDWIDTH

FULL BANDWIDTH mode

Mainframe	Bandwidth w/probe		Risetime w/probe	
	P6021	P6022	P6021	P6022
7704	50 MHz	105 MHz	7.0 ns	3.4 ns
7504	45 MHz	75 MHz	7.8 ns	4.7 ns
7503	45 MHz	75 MHz	7.8 ns	4.7 ns

20 MHz BANDWIDTH mode—20 MHz within 3 MHz.

LOWER —3 dB BANDWIDTH FREQUENCY—
With P6021—25 Hz or less, +20°C to +75°C; 30 Hz or less, 0°C to +20°C.
With P6022—250 Hz or less.

INPUT CHARACTERISTICS

	WITH P6021	WITH P6022
MAX CW CURRENT	15 A P-P to 5 MHz, decreasing to 1 A P-P at 100 MHz.	6 A P-P to 10 MHz, decreasing to 2 A P-P at 150 MHz.
MAX PULSE CURRENT	25 A peak, limited to an Amp-second product of 2.0 A-ms or 5.3 A RMS.	25 A peak, limited to an Amp-second product of 30 A-μs or 2.1 A RMS
MAX VOLTAGE	600 V (DC + peak AC)	600 V (DC + peak AC)
DC SATURATION	0.5 A	0.2 A
INSERTION IMPEDANCE	0.03 Ω at 1 MHz, increasing to 1.0 Ω at 60 MHz.	0.03 Ω at 1 MHz, increasing to 0.7 Ω at 175 MHz.

DISPLAYED NOISE

0.2 div or less throughout the calibrated deflection factor range, measured tangentially.

INCLUDED STANDARD ACCESSORIES

Two instruction manuals (070-0979-00)

7A14 CURRENT PROBE AMPLIFIER $575

U.S. Sales Price FOB Beaverton, Oregon

Please refer to Terms and Shipment, General Information page.

7A13 Differential Comparator Amplifier

NEW 7A13

DESCRIPTION

The 7A13 is a differential comparator plug-in amplifier for the 7000-Series mainframes. It incorporates a number of performance features which make it particularly versatile, especially in multi-trace combination with other 7000 series vertical plug-ins. Following is a treatment of the three operational areas which describe the functions of the 7A13.

As a conventional amplifier the 7A13 has excellent, and constant, bandwidth over the 1 mV/div to 5 V/div deflection factor range. The bandwidth is selectable at FULL (100 MHz in the 7704, 75 MHz in the 7504 and 7503) or 5 MHz for best displayed noise conditions during low frequency applications. The + or — INPUTS allow normal or inverted displays.

As a differential amplifier the 7A13 maintains its conventional features and provides a balanced (+ and —) input for applications requiring rejection of a common-mode signal. The CMRR is 20,000:1 from DC to 100 kHz, derating to 250:1 at 20 MHz. The unit can reject up to 10 V of common-mode signal at a deflection factor setting of 1 mV/div, increasing to 100 V rejection potential at 10 mV/div (X10 Vc pulled) and 500 V at 0.1 V/div.

As a comparator amplifier the 7A13 utilizes its differential capabilities but provides an accurate (0.1%) positive or negative internal offsetting voltage covering the common-mode signal range of the unit. A signal of up to ±10 V may be applied to an input (+ or —) at a deflection factor setting of 1 mV/div and, with an opposing Vc (offset voltage), viewed in 10,000 segments of 1 mV. The offset voltage is also available as an output for external monitoring.

PROBES

The P6053 (10X attenuation) is recommended with 7A13 for bandwidth and Auto Scale Factor Readout compatibility. Other Tektronix probes may be used but may not be directly compatible (consult your Tektronix Field Engineer or Representative).

SPECIFICATIONS

DEFLECTION FACTOR

1 mV/div to 5 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 1.5% with GAIN adjusted at 1 mV/div. Uncalibrated VARIABLE is continuous between steps.

BANDWIDTH

FULL BANDWIDTH Mode

Mainframe	Bandwidth —3 dB	Risetime
7704	100 MHz	3.5 ns
7504	75 MHz	4.7 ns
7503	75 MHz	4.7 ns

5 MHz BANDWIDTH Mode—DC to 5 MHz within 500 kHz.

AC COUPLED—10 Hz or less (lower —3 dB point).

INPUT R and C

1 MΩ within 0.15%; 20 pF within 0.4 pF

MAX INPUT VOLTAGE

DC COUPLED (DC + PEAK AC of 1 kHz or less)

40 V — 1 mV to 50 mV/div

400 V — 10 mV to 50 mV/div (X10 Vc out) and 0.1 V to 0.5 V/div

500 V — 0.1 V to 0.5 V/div (X10 Vc out) and 1 V to 5 V/div

AC COUPLED—400 V DC

NEW

7A13 Differential Comparator Amplifier

7A13

MAXIMUM GATE CURRENT

0.2 nA or less from 0°C to 35°C; 2 nA or less at 35°C to 50°C.

DC DRIFT

DRIFT WITH TIME (ambient temperature constant).

SHORT TERM—1 mV P-P or 0.1 div, or less (whichever is greater) over any 1-minute interval after 20 minutes warm-up.

LONG TERM—1 mV P-P or 0.1 div, or less (whichever is greater) during any 1-hour interval after 20 minutes warm-up.

DRIFT WITH AMBIENT TEMPERATURE: ≤ 2 mV/10°C or ≤ 0.2 div/10°C, whichever is greater.

DISPLAYED NOISE

200 μV, in FULL BANDWIDTH mode, measured tangentially.

OVERDRIVE RECOVERY

1 μs to recover to within 1.5 mV and 0.1 ms to recover to within 0.5 mV after the removal of an overdrive signal between +10 V and −10 V, regardless of overdrive signal duration.

COMMON-MODE REJECTION RATIO

1 mV to 50 mV/div:
DC to 100 kHz—20,000:1 (20 V P-P signal)
100 kHz to 1 MHz—10,000:1 (10 V P-P signal)
1 MHz to 10 MHz—10,000:1 at 1 MHz, deratingly linearly to 1000:1 at 10 MHz (10 V P-P signal at 1 MHz derating to 1 V P-P at 10 MHz)
20 MHz—at least 250:1 (1 V P-P signal)

10 mV to 50 mV/div (X10 Vc out) and 0.1 V to 0.5 V/div	at least 2000:1

AC COUPLED INPUT—at least 500:1 at 60 Hz

COMMON-MODE SIGNAL RANGE

1 mV to 50 mV/div	at least + and − 10 V
10 mV to 50 mV/div (X10 Vc out) and 0.1 V to 0.5 V/div	at least + and − 100 V
0.1 V to 0.5 V/div (X10 Vc out) and 1 V to 5 V/div	at least + and − 500 V

DIFFERENTIAL SIGNAL RANGE

1 mV to 50 mV/div	at least 0.8 V
10 mV to 50 mV/div (X10 Vc out) and 0.1 V to 0.5 V/div	at least 8 V
0.1 V to 0.5 V/div (X10 Vc out) and 1 V to 5 V/div	at least 80 V

LINEARITY— ≤ 1% gain change with amplitude.

INTERNAL COMPARISON VOLTAGE

RANGE—0 V to ±10 V

ACCURACY— ≤0.1% of setting, ±5 mV

ELECTRICAL ZERO—0.5 mV or less

Vc OUTPUT R—approximately 15 kΩ

INCLUDED STANDARD ACCESSORIES

Two instruction manuals (070-0978-00)

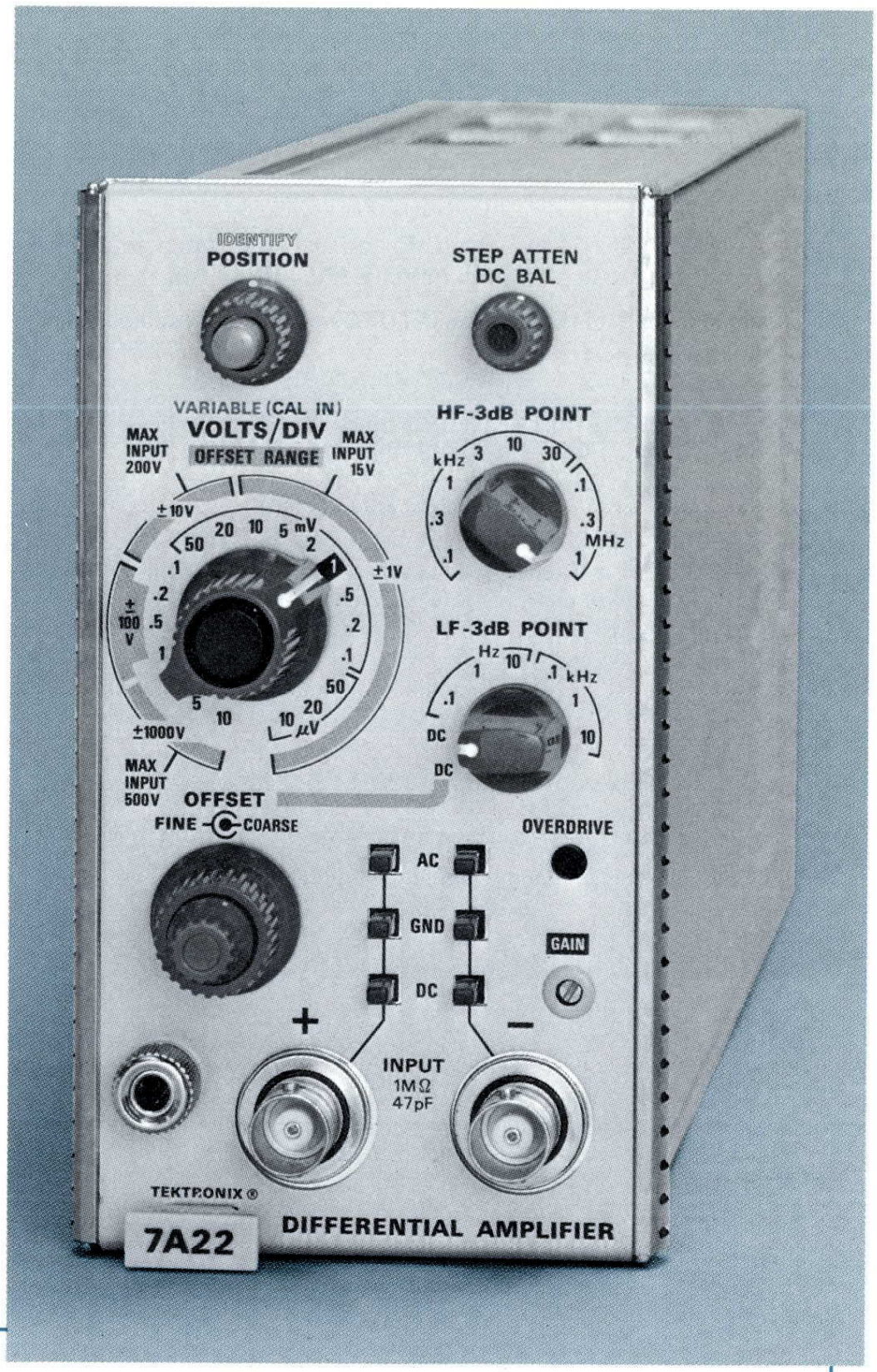
7A13 DIFFERENTIAL COMPARATOR AMPLIFIER $1100

U.S. Sales Price FOB Beaverton, Oregon

Please refer to Terms and Shipment, General Information page.

NEW

7A22 High-Gain Differential Amplifier 7A22



DESCRIPTION

The 7A22 is a differential amplifier for use with the 7000-Series mainframes. Basic performance features are 10 μV/div to 10 V/div deflection factors, DC to 1 MHz bandwidth with selectable HF and LF —3 dB POINTS, common mode rejection ratio of 100,000:1 at 10 μV/div, DC coupled, differential signal range ±1 V at 10 μV/div, and a DC OFFSET feature with ±1 V range ±100,000 divs at 10 μV/div.

There are many factors which affect the usability of high-gain, wideband differential amplifiers. Noise (if excessive) can make the high-gain positions unusable. Displayed noise (grounded inputs) is held to 16 μV at 10 μV/div, tangentially measured at full bandwidth. Since noise is related to bandwidth, the displayed noise can be greatly reduced with the HF —3 dB POINT selector when the application allows. DC drift can also hinder measurements if the trace moves off-screen rapidly. Drift with time in the 7A22 is specified at 5 μV per minute and 10 μV per hour at 10 μV/div. Drift with temperature is 50 μV/°C or less. Low amplitude signals often ride a small DC component, perhaps a few millivolts, which would place a DC-coupled display offscreen at 10 μV/div. There are three ways to reject this DC voltage in the 7A22: (1) AC coupled input if the signal frequency is high enough to be unaffected (2 Hz, LOWER —3 dB POINT). (2) AC coupling with the LF —3 dB POINT selector which allows lower bandwidth selection down to 0.1 Hz. (3) DC OFFSET which utilizes the differential feature and supplies an internal DC voltage to offset, or reject, the DC signal component. These factors, and more, make the 7A22 well suited for measurements in the difficult low-amplitude low-frequency area.

SPECIFICATIONS

DEFLECTION FACTOR

10 μV/div to 10 V/div in 19 calibrated steps (1-2-5 sequence). Accuracy is within 2% with GAIN adjusted at 1 mV/div. Uncalibrated VARIABLE is continuous between steps.

BANDWIDTH

HF —3 dB POINT—Selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz, accurate within 10% of selected frequency. Risetime in 1 MHz position is 350 ns ±9%.

LF —3 dB POINT—Selectable in 6 steps (1-10 sequence) from 0.1 Hz to 10 kHz, accurate within 12% of selected frequency. The switch also contains DC and DC with OFFSET positions. AC COUPLED (at INPUT) — 2 Hz or less.

INPUT R and C

1 MΩ within 1%; 47 pF within 2.5 pF.

MAX INPUT GATE CURRENT

10 μV to 10 mV/div — ±20 pA (+25°C), ±100 pA (50°C) each input; or ±40 pA (+25°C), ±200 pA (+50°C) differential.
20 mV to 10 V/div — ±10 pA (+25°C).

DISPLAY SHIFT—at 10 μV/div (AC coupled) is ±4 div (+25°C) and ±20 div (+50°C).

SIGNAL AND OFFSET RANGE

DEFLECTION FACTOR SETTINGS	10 μV to 10 mV/div	20 mV to 0.1 V/div	0.2 V to 1 V/div	2 V to 10 V/div
Differential Signal Range	±1 V	±10 V	±100 V	±1000 V
Common-mode Signal Range	±10 V	±100 V	±500 V	
Max DC Coupled Input (DC + peak AC at 1 kHz or less)	±15 V	±200 V	±500 V	
Max AC Coupled Input (DC voltage)	±500 V DC rejection, at least 4 x 10^5:1			
DC OFFSET RANGE	+1 V to —1 V	+10 V to —10 V	+100 V to —100 V	+1000 V to —1000 V

NEW

7A22 High-Gain Differential Amplifier 7A22

DC DRIFT

WITH TIME (ambient temperature constant).

SHORT TERM—5 μV (P-P) or 0.1 div whichever is greater in any minute after 1 hour warm-up.

LONG TERM—10 μV (P-P) or 0.1 div whichever is greater in any hour after 1 hour warm-up.

WITH AMBIENT TEMPERATURE—50 μV/°C or less.

DISPLAYED NOISE

16 μV or 0.1 div (whichever is greater) at maximum bandwidth, measured tangentially.

OVERDRIVE RECOVERY

10 μs or less to recover within 0.5% of zero level after removal of a test signal applied for 1 s (signal amplitude not to exceed differential dynamic range). A front panel OVERDRIVE light indicates an overdrive condition is being approached.

PROBES

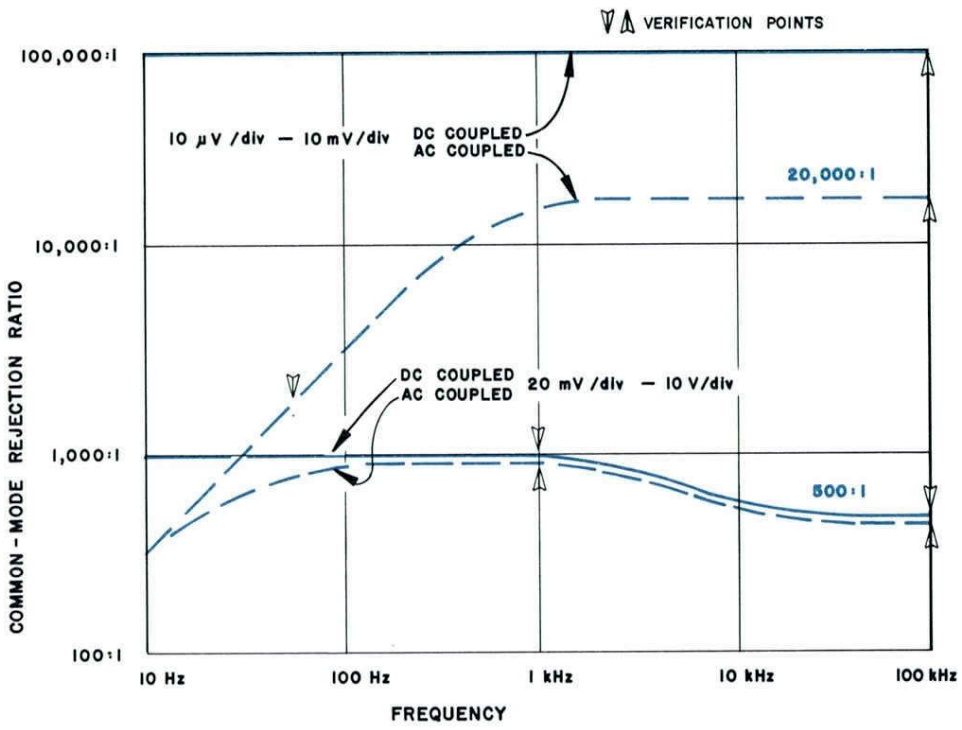
The P6052 (10X) probe is recommended for use with the 7A22 except in high CMRR applications.

INCLUDED STANDARD ACCESSORIES

Two instruction manuals 070-0931-00.

COMMON-MODE REJECTION RATIO vs FREQUENCY

(for signals not exceeding common-mode signal range)



7A22 HIGH-GAIN DIFFERENTIAL AMPLIFIER **$500**

U.S. Sales Price FOB Beaverton, Oregon

Please refer to Terms and Shipment, General Information page.

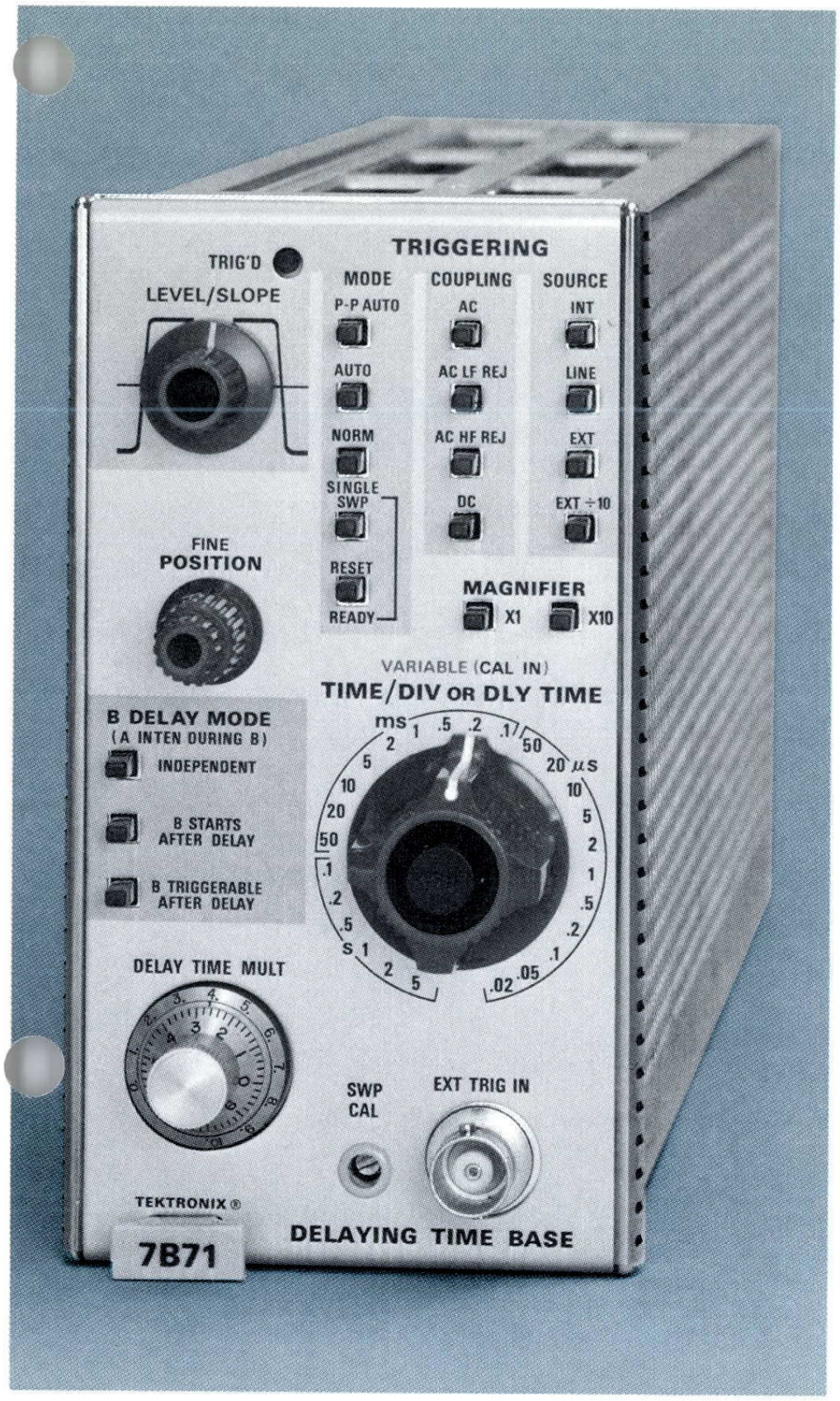
NEW

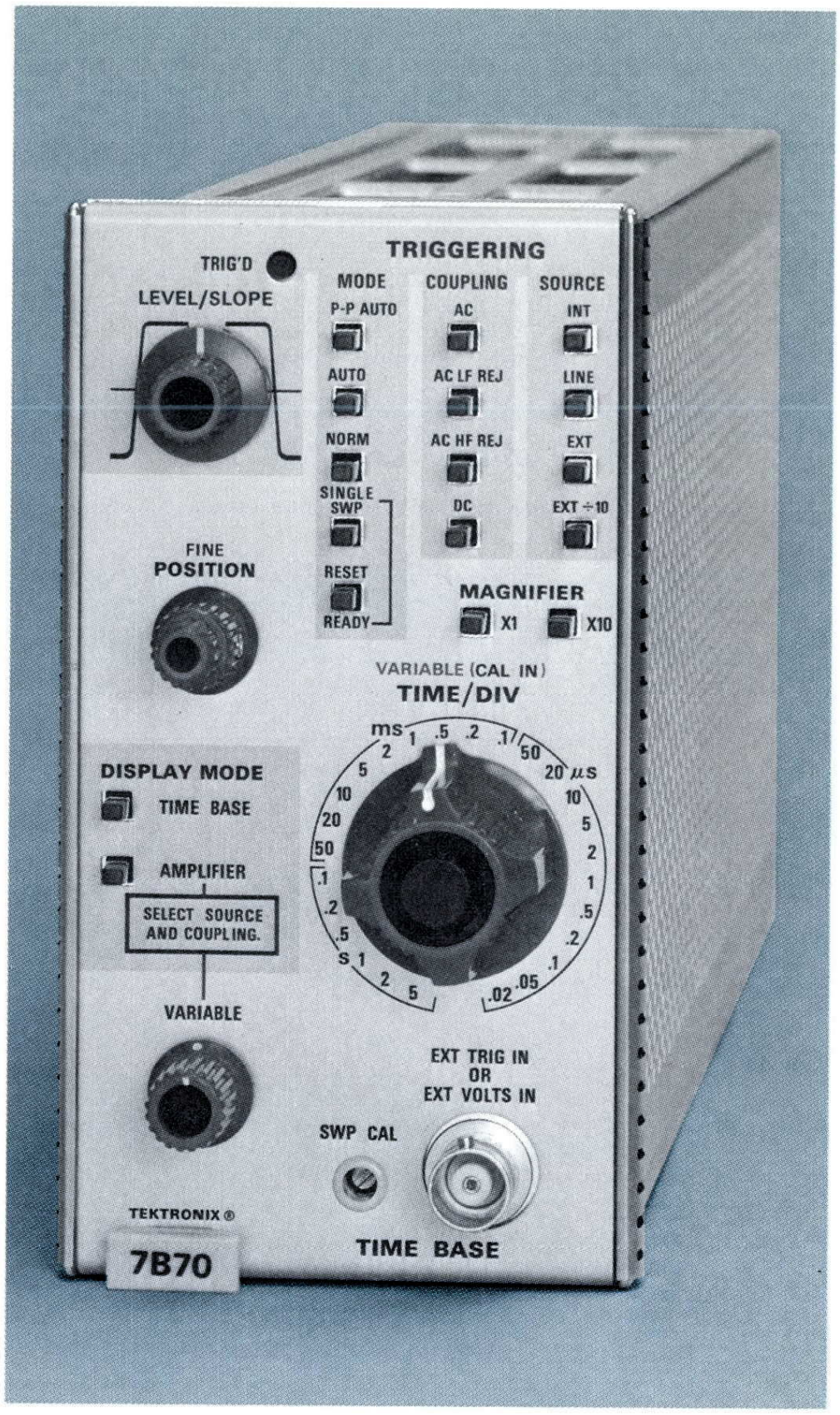
7B71

Time Base

NEW

7B70





DESCRIPTION

The 7B71 and 7B70 are horizontal TIME-BASE units intended primarily for use with the 7704 mainframe to provide bandwidth/sweep speed compatibility. However, the 7B71 and 7B70 may be used in any 7000-Series mainframe. They are identical units except in two particulars. In combination, they provide a delaying-sweep mode of operation; the 7B71 being the DELAYING SWEEP and the 7B70 the DELAYED SWEEP. The 7B70 also has a horizontal amplifier input for uncalibrated X-axis deflection from an external source.

The calibrated TIME/DIV range is from 2 ns/div to 5 s /div. The 2 ns/div rate, obtained with the X10 MAGNIFIER, complements the 2.4 ns risetime capability of the 7704 vertical system.

Triggering control is very flexible with 12 push-button positions to program MODE, method of COUPLING, and SOURCE. For routine applications, hand-off triggering is accomplished by actuating the three upper-most push-button switches: INT source, AC COUPLING, and P-P AUTO MODE which is the most generally used combination. The new P-P AUTO MODE provides a baseline trace in the absence of a signal and a triggered trace at any position of the LEVEL/SLOPE control when a signal of 0.5 div or greater is present. Except for the selection of + or — SLOPE this mode is completely automatic. The other triggering positions are useful for specific applications.

The triggering frequency range is from DC to 200 MHz, selectable within that range by the method of COUPLING. AC LF REJ attenuates undesirable trigger components below 30 kHz (60 Hz would be almost totally rejected); AC HF REJ attenuates high-frequency components (above 50 kHz) which can cause triggering problems during low-frequency applications. SINGLE-SWEEP functions with lighted READY indicators and manual reset are associated with the trigger MODE controls.

For delaying-sweep operation, the 7B71 (occupying the A horizontal channel) contains the DELAY TIME MULTIPLIER and control circuitry to release the 7B70 DELAYED SWEEP (B horizontal channel) at a predetermined point during the delaying sweep. After release, the delayed sweep can be programmed to begin immediately or wait for the next trigger event.

Both units can be used singly in the 7704, or in combination to add the delaying-sweep function and independent dual-sweep operation possible in the horizontal amplifier CHOPPED or ALT modes.

NEW

7B71

Time Base

NEW

7B70

SPECIFICATIONS

Specifications are common to both units unless otherwise noted.

SWEEP RATE

0.02 μs/div to 5 s/div in 26 steps (1-2-5 sequence). 2 ns/div is the fastest calibrated sweep rate, obtained with the X10 MAGNIFIER. The uncalibrated VARIABLE is continuous between steps and to ≃ 12.5 s/div.

SWEEP ACCURACY

Measured over the center 8 div, with the 7704 mainframe calibrator.

TIME/DIV	unmagnified		magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
5 s to 1 s/div	3%	4%	3.5%	5%
0.5 s to 0.05 μs/div	2%	3%	2.5%	4%

SWEEP LENGTH

10.5 div to 13 div.

SWEEP HOLD-OFF TIME

5 s to 5 μs/div—1.5X the TIME/DIV setting or less.
2 μs to 0.02 μs/div—3.5 μs or less.

TRIGGERING

COUPLING	Triggering Frequency Range	Min Signal Required	
		INT	EXT
AC	30 Hz - 20 MHz 20 MHz - 200 MHz	0.3 div 1.5 div	75 mV 375 mV
AC LF REJ*	30 kHz - 20 MHz 20 MHz - 200 MHz	0.3 div 1.5 div	75 mV 375 mV
AC HF REJ	30 Hz - 50 kHz	0.3 div	75 mV
DC	DC - 20 MHz 20 MHz - 200 MHz	0.3 div 1.5 div	75 mV 375 mV

*Will not trigger on sinewaves of 3 div or less INT or 1.5 V EXT below 120 Hz.

P-P AUTO OPERATION
0.5 div INT, 125 mV EXT from 200 Hz to 20 MHz.
1.5 div INT, 375 mV EXT from 20 MHz to 200 MHz.

SINGLE SWEEP—Triggering requirements are the same as normal SWEEP. When triggered, sweep generator produces one sweep only until manually or remotely reset.

INTERNAL TRIGGER JITTER—1 ns or less at 150 MHz.

EXT TRIGGER INPUT

Max input voltage—500 V (DC + peak AC of 1 kHz or less).

Input R and C—1 MΩ within 2%, 20 pF within 2 pF.

Level range (excluding P-P AUTO)

EXT—at least +1.5 V to —1.5 V.

EXT ÷ 10—at least +15 V to —15 V.

EXT HORIZONTAL INPUT (7B70 ONLY)

DEFLECTION FACTOR—25 mV/div within 5 mV when in EXT source with variable fully CW; 250 mV/div within 50 mV/div when in EXT ÷ 10 source position. The VARIABLE range is at least 10:1.

FREQUENCY RESPONSE:

COUPLING	Lower —3 dB	Upper —3 dB
AC	16 Hz	100 kHz
AC LF REJ	16 kHz	100 kHz
AC HF REJ	16 Hz	100 kHz
DC	DC	100 kHz

DELAYING SWEEP CHARACTERISTICS (7B71 ONLY)

DELAY TIME MULTIPLIER RANGE—0 to 10 times the TIME/DIV setting.

ACCURACY—5 s/div to 1 s/div within 2%.
0.5 s/div to 1 μs/div within 1%.

MULTIPLIER INCREMENTAL LINEARITY—within 0.2%.

DIFFERENTIAL TIME MEASUREMENT ACCURACY
Within 1% and 2 minor DIV—1 μs to 0.5 s.
Within 2% and 2 minor DIV—1 s to 5 s.

JITTER—1 part or less in 50,000 of 10X the TIME/DIV setting.

INCLUDED STANDARD ACCESSORIES

Two instruction manuals 7B70, (070-0982-00).
Two instruction manuals 7B71, (070-0983-00).

7B70 TIME-BASE UNIT **$600**
7B71 TIME-BASE UNIT **$685**

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

NEW

7B52 Dual Time Base 7B52

DESCRIPTION

The 7B52 Dual TIME-BASE Unit is designed specifically for use with the 7503 Mainframe; however, it is compatible with all 7000-Series Oscilloscopes. The 7B52 features calibrated sweeps from 5 s/div to 50 ns/div (5 ns/div with X10 MAGNIFICATION), triggering to 100 MHz and four different display modes.

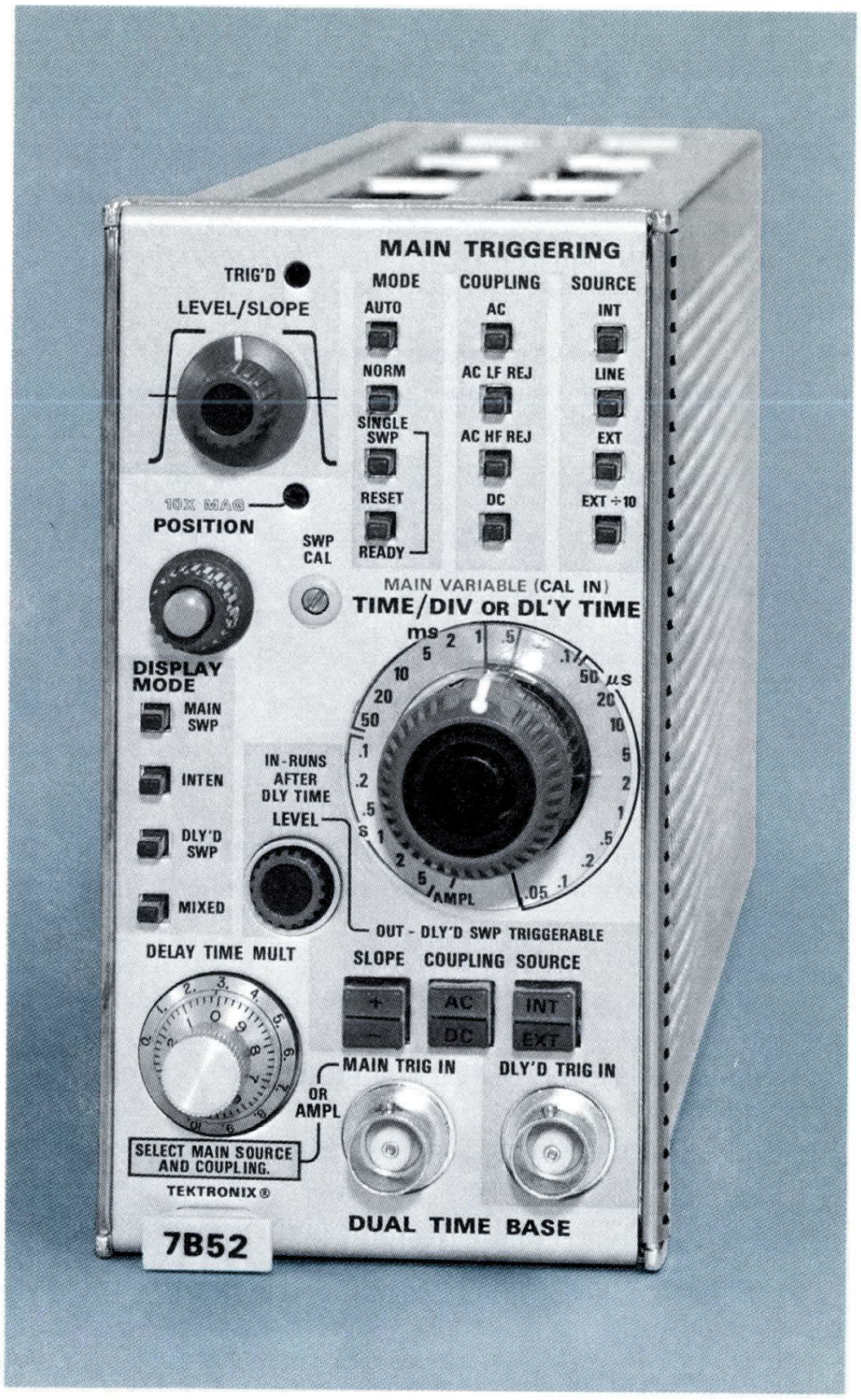
The display modes are main sweep (MAIN SWP), intensified sweep (INTEN), delayed sweep (DLY'D), and mixed sweep (MIXED). Each mode is easily selected by four separate, lighted push-button switches and two concentric TIME/DIV or DLY TIME controls. The TIME/DIV or DLY TIME controls are used to select two sweep speeds, one faster than the other, when the time base is operated in the INTEN, DLY'D or MIXED MODE.

When the MAIN SWP push button is pressed, the display is at the slower sweep speed; when the INTEN push button is pressed, the main sweep is intensified for a period of time determined by the faster sweep speed. Pressing the DLY'D push button displays only the intensified segment of the main sweep at the faster of the two sweep speeds. Pressing the MIXED push button combines the slower and faster sweep speeds into one display. The main sweep is displayed at the slower speed from the beginning of sweep to a selectable point on the main sweep. Past this point, the sweep is displayed at the faster of the two sweep speeds. The intensified zone, delayed sweep and mixed sweep may be initiated at any point on the main sweep determined by the DLY TIME MULT.

The 7B52 is designed so that the user may easily operate the time base in the many applications where delayed sweep and increased measurement accuracy are mandatory.

The main sweep triggering controls include 12 lighted, push-button switches and a LEVEL/SLOPE control which provides wide trigger flexibility. With this wide range of triggering options, the operator may quickly select the proper trigger mode even for specific applications. Triggering for routine applications can usually be solved by actuating the three upper-most push-button switches.

The DC to 100 MHz triggering frequency range is selectable by the COUPLING CONTROLS. AC LF REJ attenuates undesirable frequencies below 30 kHz which can cause triggering problems during high-frequency applications. AC HF REJ attenuates high-frequency components above 50 kHz which can cause triggering problems during low-frequency applications. In the INT (internal) mode, the trigger signal is coupled from the plug-in to the time base. This provides triggering from a single source for time-related, multiple-trace displays. The INT mode also reduces the number of applications where external triggering might otherwise be required.



The delayed sweep may be operated in either a triggered or untriggered (free run) mode. The mode is selected by a dual-purpose (push-push) control which is flush with the front panel in its latched position. In the latched position, the delayed sweep free runs after the delay time. When pressed, the control unlatches (out position) and switches the delayed sweep to a triggerable mode. In the unlatched position, the control is also the delayed sweep trigger LEVEL control.

NEW

7B52 Dual Time Base 7B52

SPECIFICATIONS

SWEEP RATE

0.05 μs/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div is the fastest calibrated sweep rate, obtained with the X10 MAGNIFIER. The uncalibrated VARIABLE is continuous between steps and to 12.5 s/div.

SWEEP ACCURACY

Measured over the center 8 div, with the 7503 mainframe calibrator.

TIME/DIV	unmagnified		magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
5 s to 1 s/div	3%	4%	3.5%	5%
0.5 s to 0.05 μs/div	2%	3%	2.5%	4%

SWEEP HOLD-OFF TIME

5 s to 5 μs/div—≤2X the TIME/DIV setting.

2 μs to 0.05 μs/div—≤2.5 μs.

DELAYING SWEEP CHARACTERISTICS

DELAY TIME ACCURACY— 5 s/div to 1 s/div, within 2%.
0.5 s/div to 1 μs/div, within 1%.

DELAY TIME MULTIPLIER RANGE—0 to 10 times the TIME/DIV setting.

DELAY TIME MULTIPLIER INCREMENTAL LINEARITY—within 0.2%.

DIFFERENTIAL TIME MEASUREMENT ACCURACY— Within 1% and 2 minor dial divisions for 1 μs to 5 s delay times. Within 2% and 2 minor dial divisions for 1 s to 5 s delay times.

JITTER—1 part or less in 20,000 of 10X the TIME/DIV setting.

TRIGGERING

COUPLING	Triggering Frequency Range	Min Signal Required INT	Min Signal Required EXT
AC	30 Hz - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	150 mV 750 mV
AC LF REJ*	30 kHz - 10 MHz 150 kHz - 10 MHz 10 MHz - 100 MHz	0.3 div ——— 1.5 div	——— 150 mV 750 mV
AC HF REJ	30 Hz - 50 kHz	0.3 div	150 mV
DC	DC - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	150 mV 750 mV

*Will not trigger on sinewaves of 3 div or less INT or 1.5 V EXT below 120 Hz.

SINGLE SWEEP—Triggering requirements are the same as normal SWEEP. When triggered, sweep generator produces one sweep only until manually or remotely reset.

INTERNAL TRIGGER JITTER—1 ns or less at 75 MHz.

EXT TRIGGER INPUT

Max input Voltage—500 V (DC + peak AC of 1 kHz or less).

Input R and C—1 MΩ within 2%, 20 pF within 5 pF.

Level Range: EXT—at least +3.5 V to −3.5 V.
EXT ÷ 10—at least +35 V to −35 V.

EXT HORIZONTAL INPUT

DEFLECTION FACTOR

EXT, MAG X10	10 mV/div within 10%
EXT	100 mV/div within 10%
EXT ÷ 10	1 V/div within 10%

FREQUENCY RESPONSE—System −3 dB points in 7500 Mainframes.

COUPLING	Lower −3 dB	Upper −3 dB
AC	40 Hz	2 MHz
AC LF REJ	16 kHz	2 MHz
AC HF REJ	40 Hz	100 kHz
DC	DC	2 MHz

INCLUDED STANDARD ACCESSORIES

Two instruction manuals 7B52 (070-1043-00).

7B52 TIME-BASE UNIT $900

U.S. Sales Price FOB Beaverton, Oregon

Please refer to Terms and Shipment, General Information page.

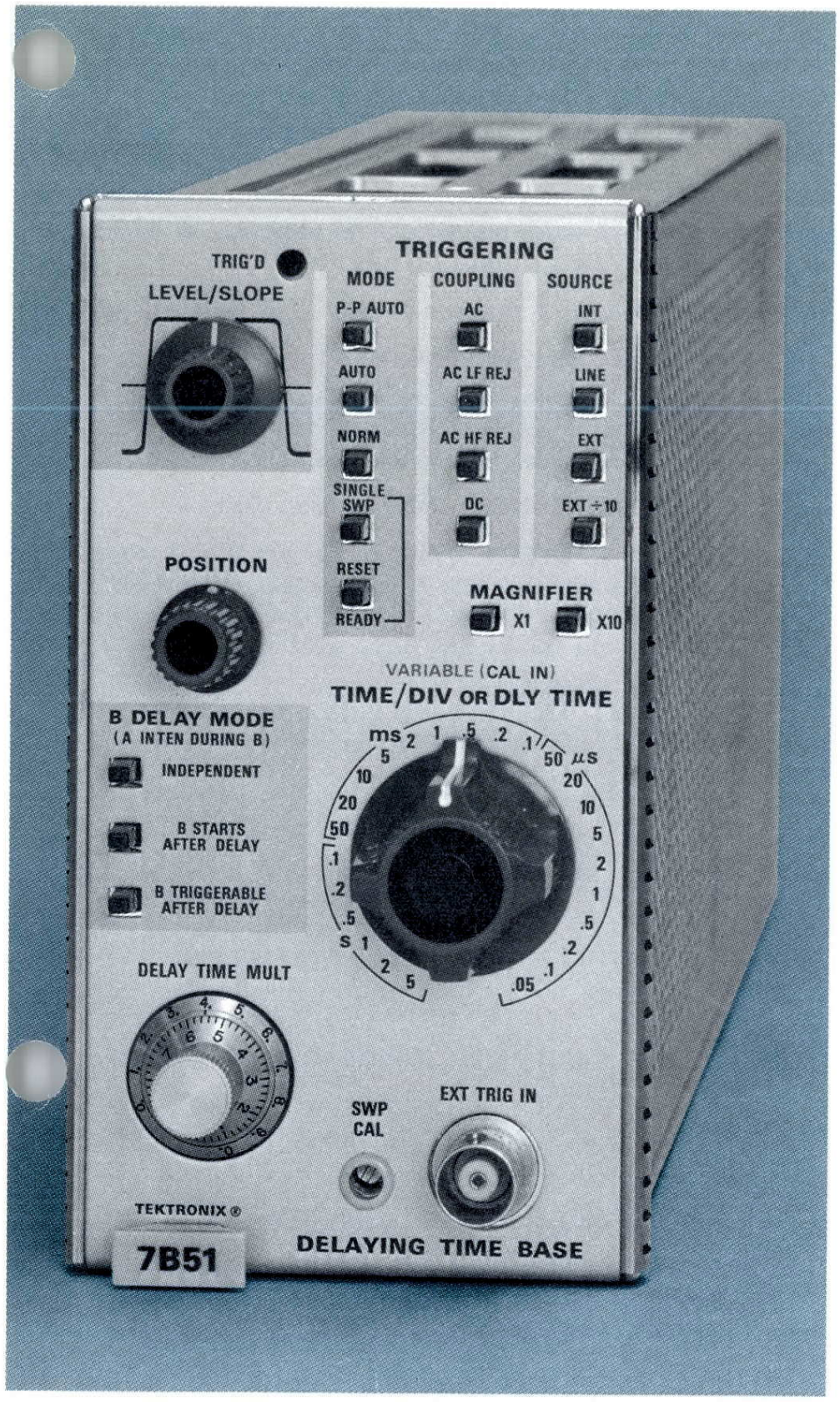
NEW

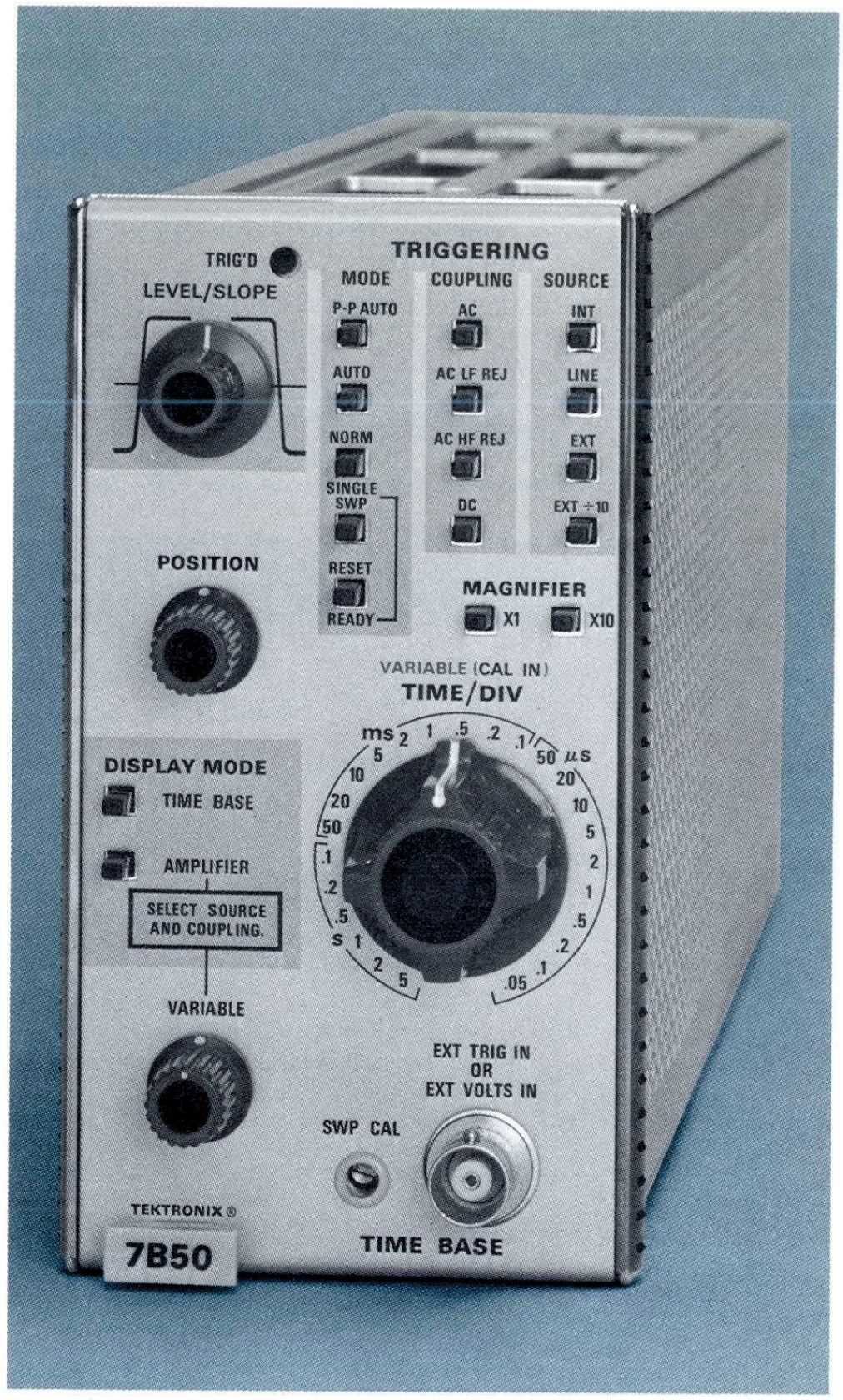
7B51

Time Base

NEW

7B50





DESCRIPTION

The 7B51 and 7B50 are horizontal TIME-BASE units designed primarily for use with the 7504 mainframe to provide bandwidth/sweep speed compatibility. However, the 7B51 and 7B50 may be used in any 7000-Series mainframe. They are identical units except in two particulars. In combination, they provide a delaying-sweep mode of operation; the 7B51 being the DELAYING SWEEP and the 7B50 the DELAYED SWEEP. The 7B50 also has a horizontal amplifier input for uncalibrated X-axis deflection from an external source.

The calibrated TIME/DIV range is from 5 ns/div to 5 s /div. The 5 ns/div rate, obtained with the X10 MAGNIFIER, complements the 3.9-ns risetime capability of the 7504 and 7503 vertical systems.

Triggering control is very flexible with 12 push-button positions to program MODE, method of COUPLING, and SOURCE. For routine applications, hands-off triggering is accomplished by actuating the three upper-most push-button switches: INT SOURCE, AC COUPLING, and P-P AUTO MODE—the most commonly used combination. The new P-P AUTO MODE provides a baseline trace in the absence of a signal and a triggered trace at any position of the LEVEL/SLOPE control when a signal of 0.5 div or greater is present. Except for the selection of + or — SLOPE this mode is completely automatic. The other triggering positions are useful for specific applications.

The triggering frequency range is from DC to 100 MHz, selectable within that range by the method of COUPLING. AC LF REJ attenuates undesirable trigger components below 30 kHz (60 Hz would be almost totally rejected); AC HF REJ attenuates high-frequency components (above 50 kHz) which can cause triggering problems during low-frequency applications. SINGLE-SWEEP functions with lighted READY indicators and manual reset are associated with the trigger MODE controls.

For delaying-sweep operation, the 7B51 (occupying the A horizontal channel) contains the DELAY TIME MULTIPLIER and control circuitry to release the 7B50 DELAYED SWEEP (B horizontal channel) at a predetermined point during the delaying sweep. After release, the delayed sweep can be programmed to begin immediately or wait for the next trigger event.

Both units can be used singly in the 7504, or in combination to add the delaying-sweep function and independent dual-sweep operation possible in the horizontal amplifier CHOPPED or ALT modes.

NEW

7B51 Time Base 7B50

NEW

SPECIFICATIONS

Specifications are common to both units unless otherwise noted.

SWEEP RATE

0.05 μs/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div is the fastest calibrated sweep rate, obtained with the X10 MAGNIFIER. The uncalibrated VARIABLE is continuous between steps and to 12.5 s/div.

SWEEP ACCURACY

Measured over the center 8 div, with the 7500 mainframe calibrator.

TIME/DIV	unmagnified		magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
5 s to 1 s/div	3%	4%	3.5%	5%
0.5 s to 0.05 μs/div	2%	3%	2.5%	4%

SWEEP LENGTH

10 div to 13 div.

SWEEP HOLD-OFF TIME

5 s to 5 μs/div—TIME/DIV setting or less
2 μs to 0.05 μs/div—2.5 μs or less

TRIGGERING

COUPLING	Triggering Frequency Range	Min Signal Required	
		INT	EXT
AC	30 Hz - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	150 mV 750 mV
AC LF REJ*	3 kHz-10 MHz 150 kHz-10 MHz 10 MHz-100 MHz	0.3 div ——— 1.5 div	——— 150 mV 750 mV
AC HF REJ	30 Hz - 50 kHz	0.3 div	150 mV
DC	DC - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	150 mV 750 mV

*Will not trigger on sinewaves of 3 div or less INT or 1.5 V EXT below 120 Hz.

P-P AUTO OPERATION
0.5 div INT, 250 mV EXT from 200 Hz to 10 MHz.
1.5 div INT, 750 mV EXT from 10 MHz to 100 MHz.

SINGLE SWEEP—Triggering requirements are the same as normal SWEEP. When triggered, sweep generator produces one sweep only until manually or remotely reset.

INTERNAL TRIGGER JITTER—1 ns or less at 75 MHz.

EXT TRIGGER INPUT

Max input voltage—500 V (DC + peak AC of 1 kHz or less).

Input R and C—1 MΩ within 2%, 20 pF within 2 pF.

Level range (excluding P-P AUTO)

EXT—at least +3.5 V to —3.5 V.

EXT ÷ 10—at least +35 V to —35 V.

EXT HORIZONTAL INPUT (7B50 ONLY)

DEFLECTION FACTOR—90 mV/div within 10 mV when in EXT source with variable fully CW; 900 mV/div within 110 mV/div when in EXT ÷ 10 source position. The VARIABLE range is at least 10:1.

FREQUENCY RESPONSE

COUPLING	Lower —3 dB	Upper —3 dB
AC	16 Hz	500 kHz
AC LF REJ	70 kHz	500 kHz
AC HF REJ	16 Hz	100 kHz
DC	DC	500 kHz

DELAYING SWEEP CHARACTERISTICS

(7B51 ONLY)

DELAY TIME MULTIPLIER RANGE—0 to 10 times the TIME/DIV setting.

ACCURACY—5 s/div to 1 s/div within 2%.
0.5 s/div to 1 μs/div within 1%.

MULTIPLIER INCREMENTAL LINEARITY—within 0.2%.

DIFFERENTIAL TIME MEASUREMENT ACCURACY
Within 1% and 2 minor div—1 μs to 0.5 s.
Within 2% and 2 minor div—1 s to 5 s.

JITTER—1 part or less in 50,000 of 10X the TIME/DIV setting.

INCLUDED STANDARD ACCESSORIES

Two instruction manuals 7B50, (070-0975-00).
Two instruction manuals 7B51, (070-0976-00).

7B50 TIME-BASE UNIT **$450**
7B51 TIME-BASE UNIT **$510**

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

NEW

7S11 Sampling Amplifier 7S11

DESCRIPTION

The 7S11 is a single-channel sampling unit for use in 7000-Series mainframes. It contains the basic deflection amplifier and control circuitry common to all sampling systems. The input configuration employs the sampling "Plug-In Head" concept for maximum application range. The heads, which mount in the 7S11, cover the impedance/bandwidth spectrum from 1 MΩ/350 MHz to 50 Ω/14 GHz. (See plug-in head descriptions.)

The 7S11 can be used in a variety of combinations. Single channel sampling would use one 7S11, together with a 7T11 Time-Base, and occupy the two center plug-in channels in the mainframe. Two 7S11's and one 7T11 would provide dual-trace sampling utilizing the electronic switching in the mainframe vertical amplifier. Two 7S11's can be used for X-Y operations, using the center two plug-in channels (RIGHT vertical and "A" horizontal channels).

An INTERNAL TRIGGER path is provided from the Plug-In Head (except for the S-3) to the 7T11 Time-Base when the INT trig mode is selected. When operating in dual-trace mode, either vertical channel may be used as the trigger source.

The 7S11 deflection factor is in UNIT/DIV (i.e., mV/DIV is determined by the plug-in head) from 2 UNITS/DIV to 200 UNITS/DIV with a continuous VARIABLE control. The DOT RESPONSE control optimizes dot transient response in the NORMAL mode. The SMOOTH position reduces display noise at the more sensitive deflection factor settings.

The ±1 V DC OFFSET can be used as a vertical magnifier/position control to view small segments of a large signal within its range, or to effectively cancel the same range of DC level on the signal. The DC OFFSET voltage is available at the OFFSET OUT jack, amplified X10, for external monitoring.

SPECIFICATIONS

DEFLECTION FACTOR

2 units/div to 200 units/div in 7 calibrated steps (1-2-5 sequence); accurate within 3%. Uncalibrated VARIABLE is continuous with a range of 0.5:1 (CCW) to 2.5:1 (CW) referenced to the UNITS/DIV setting. Deflection factor (i.e., mV/DIV) is determined by the plug-in sampling head.

BANDWIDTH

Determined by the sampling head.

INPUT R and C

Determined by the sampling head.

DC OFFSET

RANGE– +1 V to −1 V.

OFFSET OUT– X10 the offset voltage within 2%. Source resistance 10 kΩ within 1%

DELAY RANGE

At least 10 ns.

MEMORY SLASH

0.1 div or less at 20 Hz.

VERTICAL SIGNAL OUT

200 mV per displayed div within 3%.

INCLUDED STANDARD ACCESSORIES

Two instruction manuals (070-0985-00).

7S11 SAMPLING AMPLIFIER $450

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

NEW

7M11 Dual Delay Line 7M11

SPECIFICATIONS

DELAY LINE

Time Delay— 75 ns within 0.25 ns.

Delay Difference— 30 ps or less between channels.

Risetime— 175 ps or less.

Attenuation—2X within 2% into 50 Ω.

Input Impedance— 50 Ω within 1%.

Maximum Input Voltage— ±5 V.

TRIGGER OUTPUT

Risetime— 500 ps or less.

Attenuation—5X within 10% into 50 Ω (referred to INPUT).

Output Impedance— 50 Ω within 10%.

INCLUDED STANDARD ACCESSORIES

BNC cable (012-0076-00); two instruction manuals (070-0987-00); 2 nsec cable (017-0505-00).

7M11 DELAY LINE UNIT **$250**

7M11 CARRYING CASE (437-0106-00) $30

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

DESCRIPTION

The 7M11 is a passive dual DELAY LINE UNIT for use with the 7000-Series sampling system. In low-repetition rate applications, requiring the sequential mode of operation, the 7M11 provides the trigger source and signal delay necessary to view the triggering event.

Vertical delay for two 7S11 vertical sampling units is available with the dual 50-Ω, 75-ns delay lines. The closely matched (30 ps) lines have GR-874 INPUT-OUTPUT connectors, 175-ps risetime, and 2X signal attenuation. Trigger selection is from either input, 5X attenuated, with a risetime of 500 ps or less.

Sampling Time Base

7T11

NEW

DESCRIPTION

The 7T11 SAMPLING TIME-BASE provides equivalent-time and real-time horizontal deflection for single or dual-trace sampling in 7000-Series Oscilloscopes. The TIME/DIV range is calibrated from 10 ps/div to 5 ms/div, selectable with the concentric TIME POSITION RANGE, TIME/DIV and VARIABLE control. Timing accuracy is within 3% (see specifications) and non-linearity is well below 1%, making specification unnecessary. Triggering range is from $\simeq$ 10 Hz (sequential mode) to above 12.4 GHz. The following describes the modes of operation.

RANDOM SAMPLING—In this mode the triggering event may be displayed without the need of a pretrigger or signal delay line. The sampling process is controlled automatically by circuits which allow samples to be taken before, during and after the signal event of interest. The horizontal coordinate of each sample is then determined by a measurement of the time between the instant of sampling and the occurrence of a trigger. The random-sampling mode is most useful for displaying repetitive signals above 1 kHz.

SEQUENTIAL SAMPLING—When the signal repetition rate is between 10 Hz and 1 kHz, the most useful display is obtained in the sequential-sampling mode. In this mode, the sampling process is initiated by the trigger signal. As a result, either a pretrigger or signal delay line (such as the 7M11) is required to display the triggering event. For measurements which do not require display of the trigger-event (i.e., sinewaves) a pretrigger is not necessary and the decision to use random or sequential mode is based on repetition rate.

REAL TIME SAMPLING—To provide a wide measurement range, the 7T11 automatically crosses from equivalent-time to real-time sampling for the three longest Time Position Ranges (50 ms, 5 ms, 0.5 ms). In this mode, sampling occurs at a free-running (50 kHz) rate with the horizontal coordinate determined in a manner similar to that described above for Random Sampling. Lead-time is fixed at about 3 μs for this mode but time-positioning is available as in equivalent-time sampling.

TIME-POSITION RANGE—Control selects the time window from 50 ms to 50 ns in 7 steps. The TIME/DIV controls can then select all or a portion of the time window for display. Each RANGE has 9 TIME/DIV steps (1-2-5 sequence) associated with it. The displayed portion of the time window is selectable with the TIME POSITION control.

TRIGGERING CONSIDERATIONS—The unit is capable of triggering on signals in the useful sampling range from 10 Hz to above 12.4 GHz. The EXT mode has 50 Ω, 1 MΩ, and HF SYNC positions, each with its special application advantage. The 50 Ω input complements sources requiring termination and provides an optimized signal path to the DC coupled trigger recognition circuit; operation extends to 500 MHz. The 1 MΩ input inserts a X1 FET amplifier in the 50 Ω path for minimum loading of the signal source at frequencies under 100 MHz. The HF SYNC position operates from 500 MHz to above 12.4 GHz as a trigger countdown device. An INT trigger source from the 7S11 is provided (except with the S-3 plug-in head) for frequencies up to 500 MHz.

SPECIFICATIONS

TIME/DIV RANGE—10 ps/div to 5 ms/div (1-2-5 sequence) directly related to TIME POSITION RANGES. Uncalibrated VARIABLE is continuous between TIME/DIV setting and next fastest position.

TIME POSITION RANGE

Equivalent time—50 ns to 50 μs in 4 steps.

Real time—0.5 ms to 50 ms in 3 steps.

TIME/DIV ACCURACY

Within 3% for all TIME/DIV settings over center 8 cm.

TRIGGERING

EXT 50 Ω INPUT

Frequency Range—DC to 1 GHz in X1 Trig Amp Mode.

Sensitivity Range

X1 Trig Amp—5 mV to 2 V P-P, DC to 1 GHz.
X10 Trig Amp—0.5 mV to 2 V P-P, 1 kHz to 50 MHz.

Input Resistance—50 Ω within 10%.

Max Input Voltage—2 V (DC + peak AC).

EXT 1 MΩ INPUT

Frequency Range—DC to 100 MHz in X1 Trig Amp Mode.

Sensitivity Range

X1 Trig Amp—5 mV to 2 V P-P, DC to 100 MHz.
X10 Trig Amp—0.5 mV to 2 V P-P, 1 kHz to 50 MHz.

Input Resistance—1 MΩ within 5%.

Max Input Voltage—100 V P-P to 1 kHz, derating 6 dB/octave to a minimum 5 V P-P.

EXT HF SYNC

Frequency Range—1 GHz to 12.4 GHz.

Sensitivity Range—10 mV to 500 mV P-P.

Input Characteristics—1 MΩ, (3 mm connector).

Max Input Voltage—2 V P-P.

INT TRIGGER SOURCE

Frequency Range—DC to 500 MHz.

Sensitivity Range—50 mV to 1 V P-P referred to the vertical input.

RANDOM MODE TRIGGER RATE—100 Hz minimum.

DISPLAY JITTER

Time POS RNG	Sequential Mode	Random Mode
50 ms to 500 ns	0.4 div at 10 ps/div	1 div at 10 ps/div
50 ns	10 ps	30 ps

Measured under optimum trigger conditions.

PULSE OUT (into 50 Ω)

Amplitude—at least 400 mV, positive pulse.

Risetime—2.5 ns or less.

TRIGGER KICKOUT—1 mV or less into 50 Ω. (Except HF SYNC.)

DISPLAY SCAN RATE—Continuously selectable from at least 40 sweeps/s to less than 2 sweeps/s.

EXTERNAL SCAN

INPUT RESISTANCE—100 kΩ within 10%.

DEFLECTION FACTOR—Continously variable from 10 V to ≃ 1 V div.

MAXIMUM INPUT VOLTAGE—100 V (DC + Peak AC).

SWEEP OUT

1 V/div within 2%, source resistance is 10 kΩ within 1%.

INCLUDED STANDARD ACCESSORIES

Two instruction manuals (070-0986-00).
Cable, 42 inch, 50 Ω, BNC/BNC (012-0057-01).
Attenuator, 10X, 50 Ω, BNC (011-0059-01).
3 mm male to BNC adapter (015-1018-00).
3 mm male to GR874 adapter (015-1007-00).

7T11 SAMPLING TIME-BASE UNIT $1100

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

560-Series Reference

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565	Dual-Beam Oscilloscope	55
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3A72	650-kHz Dual-Trace Amplifier	66
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2A63	1-mV Differential Amplifier	70
3A3	100-μV Dual-Trace Differential Amplifier	71
3A7	1-mV Differential Comparator Amplifier	73
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The 560-Series offers total measurement capabilities through the use of 25 different plug-in units providing complete versatility in measurement applications. Mainframes include a dual-beam oscilloscope with two independent vertical and horizontal deflection systems (Type 565), a bistable storage oscilloscope (Type 564B) with and without auto-erase, and a conventional oscilloscope (Type 561B). The dual plug-in unit features of the Type 564B and 561B allows conventional displays or X-Y displays with either single-trace, dual-trace, or four-trace units. Sampling displays, as well as spectrum analysis and raster generation are also available.

With the Type 565 the horizontal amplifiers are built in and can be driven by either of its two built-in sweep generators. The vertical amplifiers can be of any 2-series or 3-series plug-in units except spectrum analyzer and sampling units.

The 560-Series is a family of valued performers.

AVAILABLE DISPLAYS

MULTI-TRACE AND SINGLE-TRACE DISPLAYS

Four-trace and dual-trace displays are obtained by selecting the Type 3A74 Four-Trace Plug-In or dual-trace plug-ins including Types 3A3, 3A6 or 3A72 Plug-Ins. All other amplifier plug-in units provide single-trace displays. Selection of the Type 2A61, 2A63, 3A3, 3A7 or 3A9 gives differential amplifier operation.

SAMPLING DISPLAYS

The Type 3T77A, 3T2 and 3T5 Sampling Sweep Units with the Type 3S1, Type 3S2, and Type 3S5 Amplifier Units give dual-trace sampling displays with risetimes in the subnanosecond region. The Type 3S2 and Type 3S5 Sampling Units feature a choice of seven sampling heads that offer new convenience and versatility when making fast pulse measurements.

SPECTRUM ANALYSIS

The Type 3L10 Spectrum Analyzer Plug-In Unit covers the 1-36 MHz range. This plug-in unit has a sensitivity of —100 dBm and calibrated dispersion.

The Type 3L5 Spectrum Analyzer Plug-In Unit provides both spectral and time-base displays from 10 Hz to 1 MHz.

AUTOMATIC SEEKING

The Types 3A5/3B5 Plug-In Units have the ability to adjust their deflection factors automatically to provide calibrated on-screen displays, at all times.

X-Y DISPLAYS

The Types 2A60, 2A61, 2A63, 3A3, 3A9, 3A72, 3A74 and 3A75 Amplifier Plug-In Units operate equally well in the vertical and horizontal compartments permitting X-Y displays using any combination of these plug-in units. Limited X-Y capabilities are provided in the Type 565 thru use of its external horizontal input feature. Plug-in units other than those listed above are not recommended for X-Y displays.

Using two Type 3A72 or two Type 3A74 Plug-In Units, both synchronization and automatic pairing are provided. Using two Type 3A3 Plug-In Units, dual-trace switching is synchronized, but there is no provision for consistent pairing each time the system is operated. Using two Type 3A6 Plug-In Units, dual-trace switching is not synchronized.

RASTER GENERATION

A raster display can be presented by using two time-base plug-in units, one in each compartment. Signal modulation can be achieved through the Z-axis of the CRT.

PLUG-IN UNITS

PLUG-IN UNIT	MINIMUM DEFLECTION FACTOR	BANDWIDTH (—3 dB)	T_R	PRICE
MULTIPLE TRACE				
3A3 Dual-Trace	100 μV/div	DC to 500 kHz	0.7 μs	$ 950
3A6 Dual-Trace	10 mV/div	DC to 10 MHz	35 ns	550
3A72 Dual-Trace	10 mV/div	DC to 650 kHz	0.54 μs	310
3A74 Four-Trace	20 mV/div	DC to 2 MHz	0.18 μs	695
DIFFERENTIAL				
2A63	1 mV/div	DC to 300 kHz	1.2 μs	$ 190
3A3	100 μV/div	DC to 500 kHz	0.7 μs	950
3A7 Comparator	1 mV/div	DC to 10 MHz	35 ns	750
3A9	10 μV/div	DC to 1 MHz	350 ns	525
SPECTRUM ANALYZERS				
3L5	*10 μV/div	10 Hz to 1 MHz		$1125
3L10	—100 dBm	1 MHz to 36 MHz Center Freq		1275
SAMPLING				
3S1 Dual Trace	2 mV/div	DC to 1 GHz	350 ps	$1350
3S2 Dual Trace	2 mV/div	Used with S-Series	Heads	950
3S5 Programmable	2 mV/div	Used with S-Series	Heads	1700
S-1	50 Ω	DC to 1 GHz	350 ps	300
S-2	50 Ω	DC to 4.5 GHz	75 ps	355
S-3	100 kΩ	DC to 1 GHz	350 ps	435
S-4	50 Ω	DC to 14 GHz	25 ps	875
S-5	1 MΩ	DC to 350 MHz	1 ns	345
S-50	25-ps Pulse Generator Head			525
S-51	1-to-18 GHz Trigger Countdown Head			500

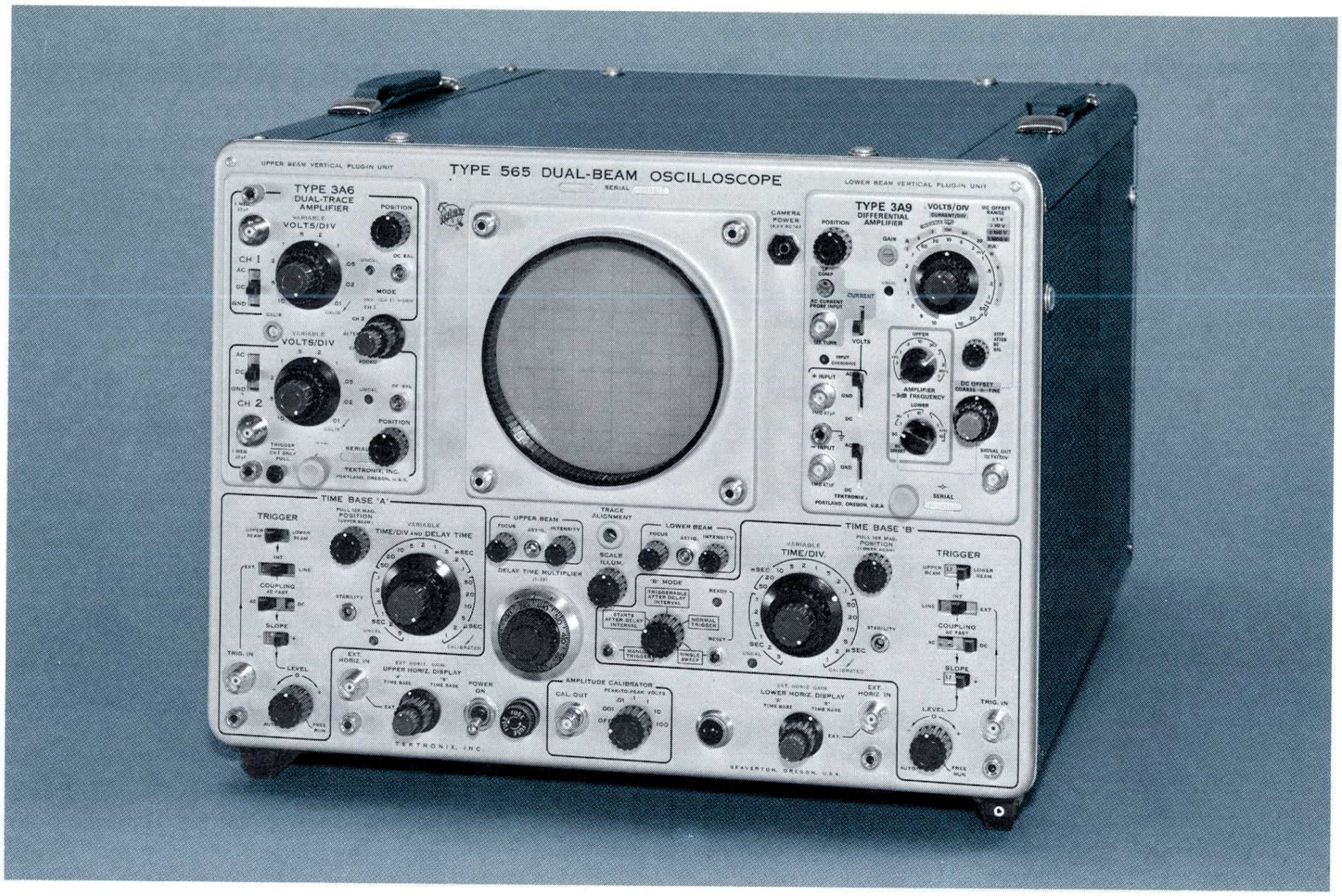
*RMS

PLUG-IN UNIT	MINIMUM DEFLECTION FACTOR	BANDWIDTH (—3 dB)	T_R	PRICE
SPECIAL PURPOSE				
3A8 Operational	20 mV/div	DC to 3.5 MHz	100 ns	$ 715
3C66 Carrier Amp	10 μstrain /div	DC to 5 kHz	70 μs	4[illegible]
SINGLE TRACE				
2A60	50 mV/div	DC to 1 MHz	0.35 μs	$ 140
3A5 Automatic/Prog	10 mV/div 1 mV/div	DC to 15 MHz DC to 5 MHz	23 ns	950
3A75	50 mV/div	DC to 4 MHz	90 ns	215

TIME-BASE UNITS

TYPE	FASTEST TIME-BASE RATE	MAGNIFIER	FEATURES	PRICE
2B67	1 μs/div	X5	single sweep	$ 235
3B3	0.5 μs/div	X5	calib sweep delay; single sweep	680
3B4	0.2 μs/div	X1 to X50	single sweep	475
3B5 Automatic/ Programmable	0.1 μs/div	X10 X100	calib delay mag; auto-seek programmable	1075
3T2	0.2 ns/div	X10	random sampling	$1100
3T5 Programmable	0.1 ns/div		calib digital sweep delay	1800
3T77A	0.2 ns/div	X10	single sweep; manual scan sweep delay	800

565 Dual-Beam Oscilloscope RM565



- ***TWO VERTICAL AND HORIZONTAL SYSTEMS***
- ***8 x 10-cm DISPLAY PER BEAM***
- ***ILLUMINATED NO-PARALLAX GRATICULE***
- ***CALIBRATED SWEEP DELAY***
- ***REAR-PANEL OUTPUT CONNECTORS***
- ***ACCEPTS WIDE VARIETY OF VERTICAL PLUG-INS***

A Type 565, or rackmount counterpart Type RM565, is essentially two single-beam oscilloscopes sharing a common cathode-ray tube and power supply. Each beam has separate vertical and horizontal deflection systems, focus, and intensity controls.

The vertical amplifiers can be any of 2-Series or 3-Series Plug-In Units, except Spectrum Analyzer and Sampling Units. The horizontal amplifiers are built-in and can be driven by either of two sweep systems, simultaneously or independently, or from their external inputs. Front-panel controls permit using "A" sweep as a delaying sweep and "B" as the delayed sweep. In this mode of operation the upper beam is intensified for duration of the "B" sweep. "B" sweep may also be used for single-sweep operation.

There are rear-panel outputs of: Vertical Signals, Horizontal Signals, + Gate, Delayed Trigger, and Auxiliary Power.

CHARACTERISTIC SUMMARY

VERTICAL

2 identical vertical-deflection systems

Vertical-deflection characteristics are extremely flexible through use of 2-Series and 3-Series Plug-In Units (see chart).

HORIZONTAL

2 independent horizontal-deflection systems

CALIBRATED TIME BASE—1 μs/div to 5 s/div.

10X MAGNIFIER—Extends time base to 0.1 μs/div.

CALIBRATED SWEEP DELAY—5 μs to 50 s.

EXTERNAL INPUT—Approx 100 mV/div to 30 V/div.

CRT

DISPLAY AREA—10 x 10 cm (each beam scans 8 cm vertical, overlap of the two beams is 6 cm). Major graticule division equals 1 cm, minor division equals 2 mm. Illuminated no-parallax graticule.

ACCELERATING VOLTAGE—4 kV.

PHOSPHOR—P2

OTHER

AMPLITUDE CALIBRATOR—1 mV to 100 V, 1-kHz squarewave.

REAR-PANEL SIGNAL OUTPUTS—Output impedance approx 500 ohms; max load 2 mA.

POWER REQUIREMENTS—105 to 125 V or 210 to 250 V, 600 watts.

VERTICAL DEFLECTION

2 identical systems

Characteristics of the two vertical systems depend upon the 2-Series or 3-Series Amplifier Units used. Please refer to the plug-in chart for more information on these vertical amplifier units. (The 565 does not use Sampling or Spectrum Analyzer Plug-In Units.)

VERTICAL PLUG-IN UNITS*				
PLUG-IN UNIT	MINIMUM DEFLECTION FACTOR	BANDWIDTH (—3 dB)	T_R	PRICE
MULTIPLE TRACE				
3A3 Dual-Trace	100 μV/div	DC to 500 kHz	0.7 μs	$950
3A6 Dual-Trace	10 mV/div	DC to 10 MHz	35 ns	550
3A72 Dual-Trace	10 mV/div	DC to 650 kHz	0.54 μs	310
3A74 Four-Trace	20 mV/div	DC to 2 MHz	0.18 μs	695
SINGLE TRACE				
2A60	50 mV/div	DC to 1 MHz	0.35 μs	$140
3A5 Automatic/Prog	10 mV/div 1 mV/div	DC to 15 MHz DC to 5 MHz	23 ns	950
3A75	50 mV/div	DC to 4 MHz	90 ns	215
SPECIAL PURPOSE				
3A8 Operational	20 mV/div	DC to 3.5 MHz	100 ns	$715
3C66 Carrier Amp	10 μstrain /div	DC to 5 kHz	70 μs	495
DIFFERENTIAL				
2A63	1 mV/div	DC to 300 kHz	1.2 μs	$190
3A3	100 μV/div	DC to 500 kHz	0.7 μs	950
3A7 Comparator	1 mV/div	DC to 10 MHz	35 ns	750
3A9	10 μV/div	DC to 1 MHz	350 ns	525

*2- and 3-Series Time Base Plug-Ins can be used for raster generation.

HORIZONTAL DEFLECTION

2 identical systems

TIME BASE A AND B

1 μs/div to 5 s/div in 21 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable and to approx 12 s/div. A warning light indicates when the variable control is in the uncalibrated position. Either time base can be operated independently, or Time Base B can be delayed by Time Base A. In delayed-sweep operation, Time Base A display is intensified for the duration of the "B" sweep.

X10 MAGNIFIER

Operates over full time base, increases fastest rate to 0.1 μs/div. Magnified time base accurate within 5%.

OPERATING MODES

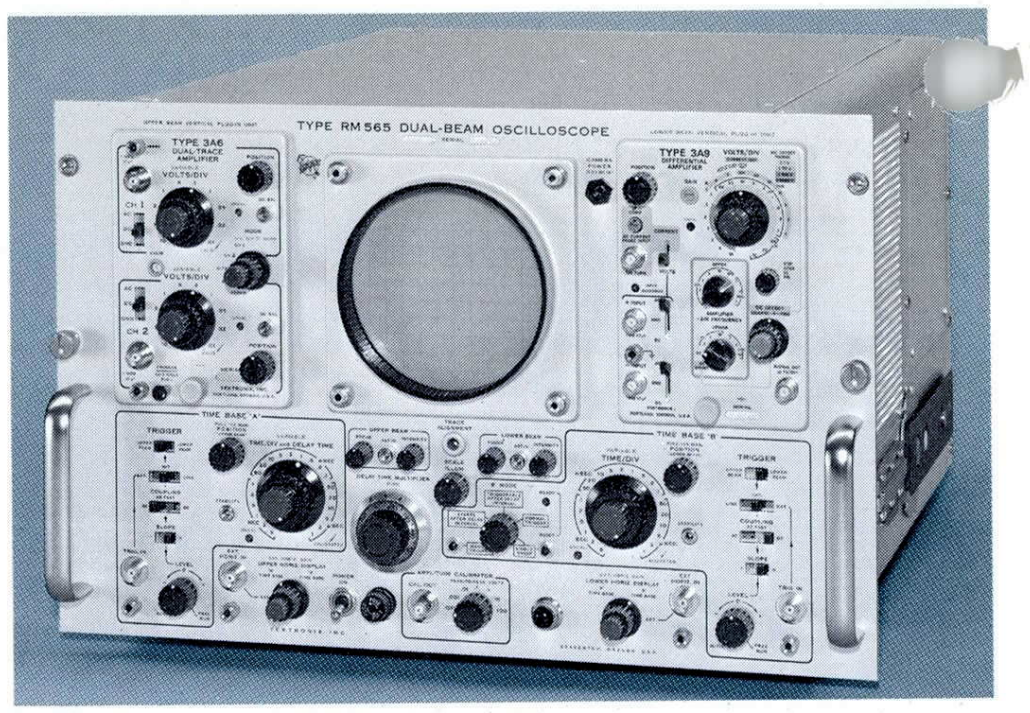
Time Base A—Normal Sweep.
Time Base B—Normal, B delayed by A, and Single Sweep.

DELAY MODES

Delayed sweep starts immediately at end of delay time, or is triggerable at end of delay time (for jitter-free displays).

DELAYED SWEEP MODE

Delayed sweep starts after time interval determined by DELAY TIME and DELAY-TIME MULTIPLIER. DELAY TIME control selects 10 μs to 5 s delay time in a 1-2-5 sequence, accurate to within 3% (5, 2, and 1 μs delay time, accuracies not specified). DELAY-TIME MULTIPLIER accurate within 0.5% of full scale. Provides continuously calibrated time intervals from 0.50 to 10.00 times the DELAY TIME. Dial is divided into 1000 parts.



DIFFERENTIAL TIME-MEASUREMENT ACCURACY

Within 3% and 10 minor divisions. Jitter ≤1 part in 20,000 of 10 times DELAY TIME.

DELAY RANGE

5 μs to 50 s after start of delaying sweep. Inherent delay to start of delayed sweep is 1.5 μs or less.

EXTERNAL INPUT

Upper and Lower Horizontal Display Switches select Time Base A, Time Base B, or Ext. In the External position, the gain is continuously variable from approx 100 mV/div to 30 V/div, DC to 350 kHz. Maximum input voltage is 300 V RMS. Input RC is approx 100 kilohms paralleled by 30-55 pF depending on gain setting.

TRIGGER

2 identical systems

MODES

Manual, Automatic, Free-run. In Automatic mode, sweep free-runs at approx 50 Hz in the absence of a triggering signal.

COUPLING

AC, AC Fast, DC.

SOURCES

Internal from Upper Beam or Lower Beam, External, or Line.

REQUIREMENTS

0.2 divisions of deflection internal or 0.5 V external up to 50 kHz, increasing to 1 div or 1 V at 2 MHz.

CRT AND DISPLAY FEATURES

TEKTRONIX DUAL-BEAM CRT

5-inch round tube, 10 x 10-cm display area; 8 x 10 cm per beam with 6-cm overlap. Tube is aluminized with illuminated, internal, no-parallax graticule. Accelerating potential is 4 kV. P2 phosphor is normally supplied, P7, P11, or P31 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability.

DISPLAY CONTROLS

Separate intensity, focus and astigmatism controls for each beam, intensity contrast between A sweep and non-intensified B-zone of A sweep (internal screwdriver adjustment), trace rotation.

Z-AXIS MODULATION

AC-coupled to both CRT grids via rear panel input connectors. Time constant is 3.5 ms nominally, CRT modulation requires approx 10 V at normal intensity.

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR

1-kHz squarewave output, calibrated in 6 steps from 1 mV to 100 V. Accurate within 3%.

REAR-PANEL OUTPUTS

VERTICAL SIGNAL OUT (both upper and lower)—Signal amplitude, DC level, and transient response depend on the vertical plug-in unit used. Typical signal amplitude: 2 V/div to 4 V/div of display; DC level ±20 V. Output impedance: approx 500 ohms; maximum load current 2 mA.

HORIZONTAL OUTPUTS (both upper and lower)—Signal amplitude, at least 50 mV/div of display in External position and 0.5 V/div of display in Sweep position. DC level 0 to +5 volts. Output impedance: approx 500 ohms; maximum load current 2 mA.

A AND B +GATES—Pulse height 20 V minimum; DC level zero volts. Output impedance: approx 500 ohms; maximum load current 2 mA.

DELAYED TRIGGER—Fast-rise pulse amplitude +8 V minimum; DC level zero volts. Output impedance: approx 50 ohms; maximum load current 2 mA.

POWER REQUIREMENTS

600 watts maximum, 50 to 60 Hz. Instrument factory wired for 105-V to 125-V (117 V nominal) operation, or 210 V to 250 V (234 V nominal) upon request. Transformer taps permit operation at nominal voltages ranging from 99 V to 132 V or 198 V to 265 V.

CABINET MODEL DIMENSIONS AND WEIGHTS

Height	13¾ in	34.9 cm
Width	16⅞ in	42.8 cm
Depth	23⁹⁄₁₆ in	59.8 cm
Net weight	67 lb	30.5 kg
Domestic shipping weight	≈95 lb	≈43.2 kg
Export-packed weight	≈117 lb	≈53.2 kg

RACK MODEL DIMENSIONS AND WEIGHTS

Height	12¼ in	31.1 cm
Width	19 in	48.3 cm
Rack depth	22³⁄₁₆ in	56.4 cm
Net weight	68 lb	30.9 kg
Domestic shipping weight	≈104 lb	≈47.3 kg
Export-packed weight	≈124 lb	≈56.4 kg

RACKMOUNTING

Type RM565 mounts on tilting slide-out tracks to standard 19-inch rack. Additional mounting information on catalog instrument dimension page.

INCLUDED STANDARD ACCESSORIES

3- to 2-wire adapter (103-0013-00); 3-conductor power cord (161-0010-03); smoke-gray filter (installed) (378-0567-00); clear CRT protector plate (387-0918-00); two patch cords, BNC-to-BNC 18-inch (012-0087-00); post jack, BNC (012-0092-00); two instruction manuals (070-0269-00). Type RM565 also includes 1 pair mounting tracks (351-0086-00); power cord (161-0024-03); two instruction manuals (070-0353-00).

TYPE 565 OSCILLOSCOPE without plug-in units . **$1675**

TYPE RM565 OSCILLOSCOPE without plug-in units . **$1775**

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience. The probes recommended for use with these instruments are covered on the 2- and 3-Series Plug-In Unit pages. Additional probes are available that may be better suited for a particular application, including current and high-voltage measurements. See the catalog accessory pages for information on these and other items.

CAMERAS

C-27-547: f/1.9—1:0.7 lens, Polaroid Land[1] Pack-Film back provides 10 x 10-cm coverage on 3¼ x 4½ film, order C-27-547 ..... $480

C-27G: f/1.9—1:0.85 lens, no back, provides 10 x 10-cm coverage on 4 x 5 film with optional Graflok[2] back and Polaroid Land film holder, order C-27G $380

Graflok back for 4 x 5 film holder (not included), order 122-0604-00 ..... $ 50

Type 565, RM565 to C-27-547 or C-27G Camera adapter, order 016-0225-02 ..... $ 16

SCOPE-MOBILE® CART

Model 205-3: holds 4 plug-in units, has 9-position tilt-lock oscilloscope tray, order 205-3 ..... $160

CRADLE ASSEMBLY

Provides rear slide support when RM565 is mounted in backless rack, order 040-0346-00 ..... $ 10

[1]Registered Trademark Polaroid Corporation.

[2]Registered Trademark Graflex Inc.

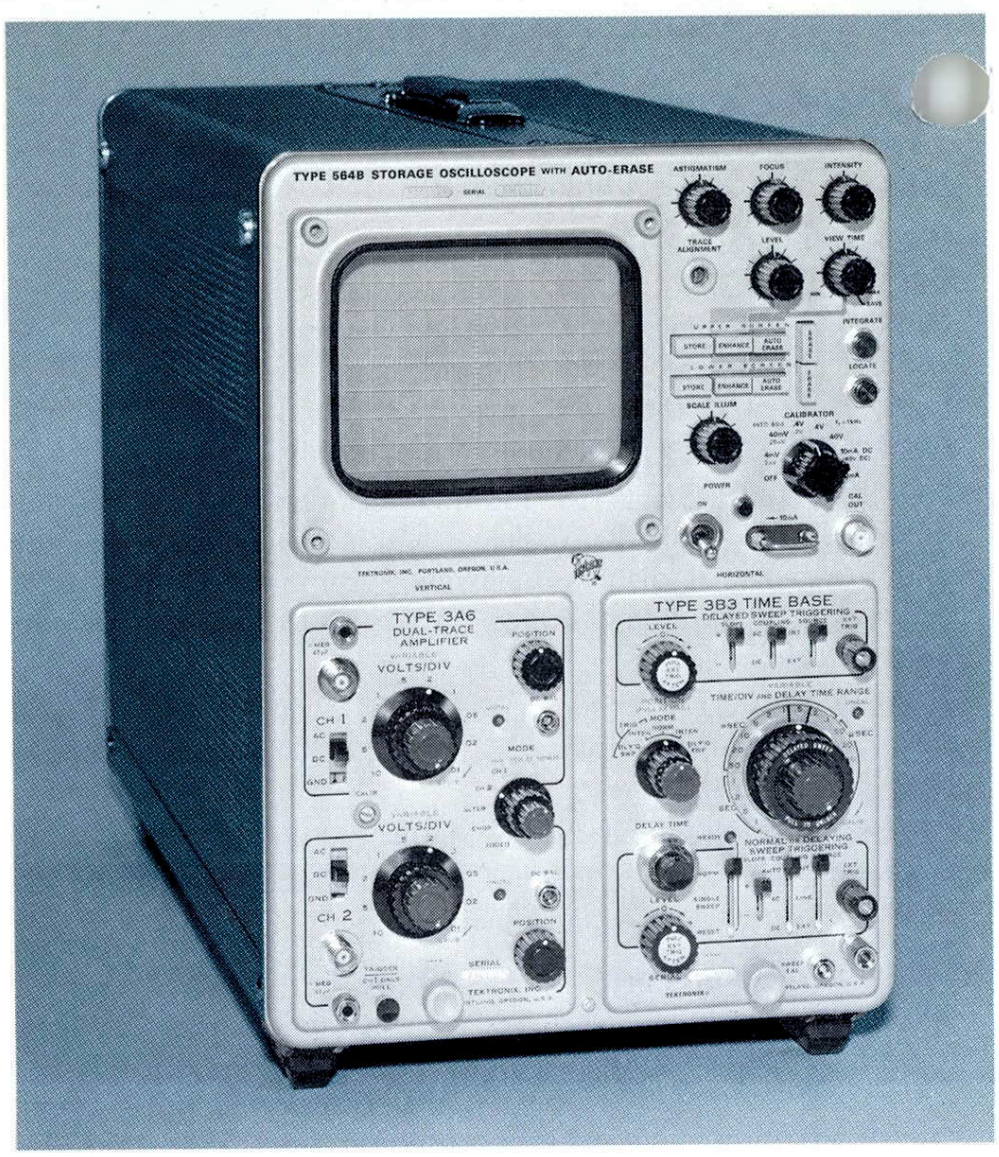
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

564B MOD 121N

Auto-Erase Storage Oscilloscope

R564B MOD 121N

- ***BISTABLE SPLIT-SCREEN STORAGE***
- ***UP to 500 cm/ms WRITING SPEED***
- ***ACCEPTS MULTI-TRACE, DIFFERENTIAL, SAMPLING AND SPECTRUM ANALYZER PLUG-IN UNITS***
- ***REMOTE ERASE***
- ***X-Y DISPLAYS***
- ***VARIABLE VIEWING TIME 1 s to 12 s***



The Type 564B MOD 121N Storage Oscilloscope, and its rackmount counterpart, is virtually two instruments in one, offering all the advantages of a conventional plug-in oscilloscope plus the added advantages of a split-screen, storage CRT and the convenience of a variable viewing-time system. Through front panel controls this system can be directed to automatically erase either or both halves of the display area after a predetermined viewing time. Viewing time can be varied from 1 s to 12 s in the auto-erase mode. A complete selection of plug-ins permits changing the oscilloscope's performance to meet changing measurement needs.

With the split-screen storage feature, either half of the 8 x 10-cm display can be independently controlled, thus allowing stored or conventional displays on either the upper or lower half. The contrast ratio and brightness of the stored displays are constant and independent of viewing time, writing and sweep rates, or signal repetition rates.

The Type 564B MOD 121N and R564B MOD 121N have dual plug-in flexibility with vertical and horizontal plug-in units. Amplifier plug-ins offer a wide range of measurement capabilities with 10-MHz multi-trace, 10 μV differential, 25-ps sampling and spectrum analyzer plug-ins. Time-base plug-ins include delayed sweep, X50 magnifier, single time bases and sampling time bases. Amplifier plug-ins may be placed in the horizontal position for X-Y or multiple X-Y displays, and automatic seeking plug-ins are available.

Occupying only 7 inches of rack height, the Type R564B MOD 121N bolts directly to the rack, but may be ordered with optional slide-out tracks at additional cost.

The Type 564B MOD 121N and R564B MOD 121N offer reliable operation with low-heat dissipation through the use of solid-state components.

CHARACTERISTIC SUMMARY

VERTICAL

Vertical deflection characteristics are extremely flexible through use of 2-Series and 3-Series Amplifier Plug-In Units.
Dual Trace—DC to 10 MHz, 35 ns.
Differential—DC to 1 MHz, 10 μV/div.
Sampling—DC to 14 GHz, 25 ps.
Spectrum Analyzer—10 Hz to 36 MHz.

HORIZONTAL

Horizontal deflection characteristics are extremely flexible through the use of versatile 2-Series and 3-Series Amplifier and Time-Base Units.

STORAGE CRT

DISPLAY AREA—8 x 10 cm.
ACCELERATING VOLTAGE—3.5 kV.
SPLIT-SCREEN STORAGE—Store on either upper or lower half of screen with non-storage on other half; store on entire screen; or non-store on entire screen.
VIEWING TIMES—Up to one hour.
ERASE TIME—Approximately 0.25 second.
WRITING SPEED—Up to 500 cm/ms.
PHOSPHOR—Similar to P1.

OTHER

CALIBRATOR—4 mV to 40 V (±1.5%), 1 kHz (±1%) squarewave and 40 V DC. Into 50.0 Ω, 2 mV, 20 mV and 200 mV squarewave. Current loop of 10 mA DC and 10 mA squarewave (±1.5%).
LINE VOLTAGE REQUIREMENTS—90 V to 136 V or 180 V to 272 V, 48 Hz to 440 Hz (564B), 48 Hz to 66 Hz (R564B).

564B MOD 121N

Auto-Erase Storage Oscilloscope

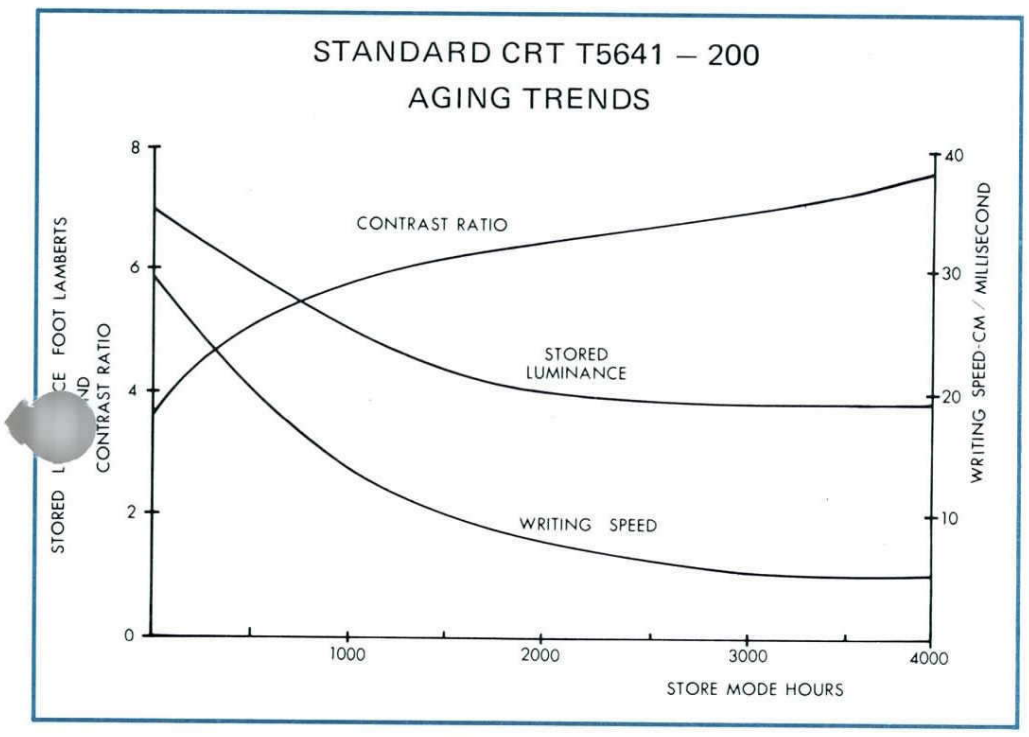
R564B MOD 121N

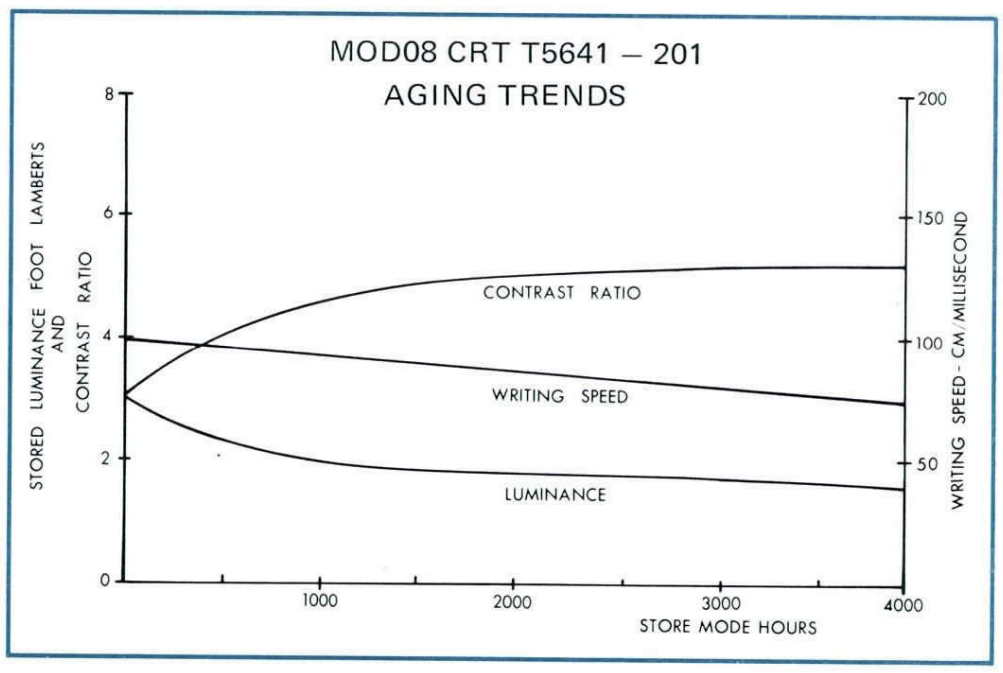
CRT PERFORMANCE

There are two storage tubes available for use in the Type 564B Oscilloscopes. Both tubes exhibit characteristics of a conventional CRT when used in the non-stored mode. The standard tube, the T5641-200, has the brighter stored display. The other tube, the T5641-201, has the faster writing speed.

By selecting the proper tube, you can obtain optimum oscilloscope performance for your particular application. Such selection is important because each tube has its own maximum writing speed and brightness for stored-mode operation. The brightness of a stored display for an individual tube is one value regardless of the intensity of the beam that generated it.

The hours shown are the actual hours the CRT is used in the stored mode with repetitive writing, storing, and erasing. It should be noted that non-storage operation of the CRT has little effect on the age characteristics shown. Therefore to obtain maximum CRT performance and service, the oscilloscope should be in the non-stored mode when stored displays are not needed.





TEKTRONIX STORAGE CRT

The CRT is a Tektronix Type T5641, flat-faced bistable storage tube with beam-deflection blanking and an accelerating voltage of 3.5 kV. It has an 8 x 10-cm storage target divided into two 4 x 10-cm areas, individually controllable for storage and erasure.

STORAGE CHARACTERISTICS

VIEWING TIME

Displays can be stored for viewing up to 1 hour. Longer times may be obtained but tend to reduce target sensitivity in the stored areas.

ERASURE TIME

Approximately 0.25 second.

STORED WRITING-SPEED ENHANCEMENT

This feature controls the single-sweep storage capabilities of the storage CRT. Through adjustment of the front-panel Level control, single-trace spot velocities up to 250 cm/ms using the standard CRT; up to 500 cm/ms using the MOD 08 CRT can be stored with minimal loss of resolution and contrast in the center 7 x 9 cm.

SINGLE-SHOT SIGNALS

At slow or medium speeds, single-shot signals are easily stored for extended viewing time (within writing-speed capabilities of CRT selected).

INTEGRATE MODE

Increases the effective writing speed for repetitive fast signals with repetition rates that are too low for effective storage, but which may be too fast for satisfactory single-shot storage with enhancement.

REMOTE CONTROL OPERATION

A rear-panel connector permits erasing of upper and/or lower half of split screen from a remote location and permits remote operation of the Save Mode.
Erasure can be initiated in either of two ways:

1. Pulse initiated—Requires a negative pulse of 5 V to 100 V. Rate of change at least 0.1 V/μs.
2. Impedance change initiated—Requires a change from at least 1 MΩ to 50 kΩ or less in 10 μs or less.

AUTO ERASE

In the Auto Erase Mode there is a continuous sequence of storing, viewing time and erasure of either upper screen, lower screen or entire screen. A rear-panel switch provides two modes of operation, either Signal Triggered Sweep or Erase Triggered Sweep.

SIGNAL TRIGGERED SWEEP

In the Signal Triggered Sweep Mode, the input Signal initiates a sweep and the viewing time begins as the sweep ends. At the end of the variable viewing time, the selected portion of the screen is automatically erased and the cathode-ray tube is unblanked after the next sweep retrace. This cycle will automatically repeat itself as long as an input signal triggers the sweep.

ERASE TRIGGERED SWEEP

The Erase Triggered Sweep Mode is primarily useful with sweep rates of 0.1 s/div and slower. In this mode of operation, the CRT is not blanked during the variable viewing time. The sweep unit can be triggered either by the input signal or by the erase pulse output located on the rear of the oscilloscope.

VARIABLE VIEWING TIME

1 s to at least 12 s. SAVE position disables automatic erasure.

564B MOD 121N Auto-Erase Storage Oscilloscope R564B MOD 121N

TYPE 564B CHARACTERISTICS

PLUG-IN COMPARTMENTS

The instrument accepts 2-Series and 3-Series Amplifier and Time-Base Units except Type 3T6 and Type 3S6.

LOCATE BUTTON

This button, when depressed, causes a spot or spots to appear at the left of the CRT screen at the vertical position of the next sweep.

EXTERNAL GRATICULE

The graticule is edge lighted and is marked in 8 vertical and 10 horizontal cm divisions. The centerline is marked every 2 mm. Illumination is controlled by a front-panel knob.

Z-AXIS INPUT

Accessible through a BNC connector at the rear of the instrument permitting external modulation of the CRT cathode. Z-axis input is AC coupled to the CRT cathode and requires 10 V P-P for beam modulation at normal intensity.

AMPLITUDE CALIBRATOR

Front-panel selection of calibration signals.

Voltage—4 mV, 40 mV, 400 mV, 4 V and 40 V ground-to-peak squarewave into 1 MΩ or greater; 40 V DC into 1 MΩ or greater; 2-mV, 20-mV or 200-mV ground-to-peak squarewave into 50.0 Ω.

Current—Current loop of 10 mA DC or 10-mA ground-to-peak squarewave.

Voltage and current amplitude accuracy is within 1½% from +20°C to +30°C; within 2% from 0°C to +50°C. Squarewave frequency is 1 kHz, within 1%. Risetime and falltime is 1 μs or less with load capacitance of 100 pF or less except in the 40-V position where t_r and t_f is 2.5 μs or less with load capacitance of 100 pF or less.

ENVIRONMENTAL CHARACTERISTICS

AMBIENT TEMPERATURE

Operating: 0°C to +50°C

Non-operating: —40°C to +65°C

ALTITUDE

Operating: to 15,000 feet; maximum allowable ambient temperature decreased 1°C/1,000 feet from 5,000 to 15,000 feet.
Non-operating: to 50,000 feet.

TRANSPORTATION

18 inch package drop. Cabinet model qualified under the National Safe Transit Committee Test procedure 1A.

ELECTRONICALLY REGULATED SUPPLIES

Regulated power supplies furnish all voltages required for proper operation of the Indicator and the plug-in units.

POWER REQUIREMENTS

Quick-change, line voltage selection permits operation from any of the following voltages: 90 to 110 V, 104 to 126 V, 112 to 136 V, 180 to 220 V, 208 to 252 V, 224 to 272 V. The Type 564B MOD 121N will operate over a line-frequency range from 48 Hz to 440 Hz with a power consumption of 196 watts at 115 VAC, 60 Hz. The Type R564B MOD 121N will operate over a line frequency from 48 Hz to 66 Hz, with a power consumption of 204 watts at 115 VAC, 60 Hz.

TYPE 564B MOD 121N DIMENSIONS AND WEIGHTS

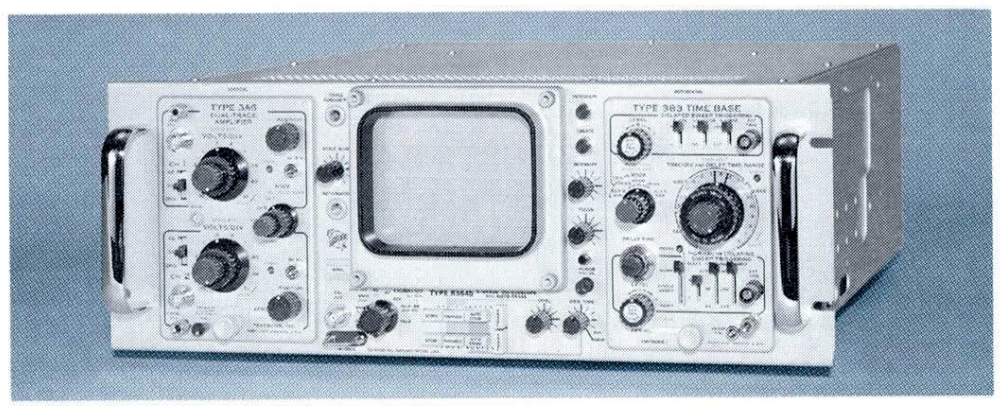
Height	14¾ in	37.5
Width	9¾ in	24.8
Depth	21½ in	54.7 cm
Net weight	34¾ lb	15.7 kg
Domestic shipping weight	≈41 lb	≈18.6 kg
Export-packed weight	≈53 lb	≈24.0 kg

STANDARD ACCESSORIES FOR TYPE 564B MOD 121N

3- to 2-wire adapter (103-0013-00); BNC-post jack (012-0092-00); 50-Ω BNC cable (012-0057-01); adapter, BNC to dual banana connector (103-0090-00); two instruction manuals (070-0806-00).

TYPE 564B MOD 121N OSCILLOSCOPE, without plug-in units **$1250**
(with CRT for stored display of highest intensity).

TYPE 564B MOD 121N, MOD 08 OSCILLOSCOPE, without plug-in units **$1250**
(with CRT for fastest stored writing speed).



TYPE R564B MOD 121N DIMENSIONS AND WEIGHTS

Height	7 in	17.8 cm
Width	19 in	48.3
Rack depth	20½ in	52.1
Net weight	34 lb	15.4 kg
Domestic shipping weight	≈57 lb	≈25.8 kg
Export-packed weight	≈77 lb	≈34.9 kg

STANDARD ACCESSORIES FOR TYPE R564B MOD 121N

Mounting hardware (016-0131-00); BNC-post jack (012-0092-00); 50-Ω BNC cable (012-0057-01); adapter, BNC to dual banana connector (103-0090-00); two instruction manuals (070-0807-00).

TYPE R564B MOD 121N OSCILLOSCOPE, without plug-in units **$1300**
(with CRT for stored display of highest intensity).

TYPE R564B MOD 121N, MOD 08 OSCILLOSCOPE, without plug-in units **$1300**
(with CRT for fastest stored writing speed).

TYPE R564B MOD 121N WITH SLIDE-OUT TRACKS

Type R564B MOD 121N, MOD 171A or Type R564B MOD 121N, MOD 08, MOD 171A mounts to a standard 19-inch rack on slide-out tracks. It can be pulled out, tilted and locked in any one of seven positions for convenient servicing. Instrument has same standard accessories as the Type R564B MOD 121N, but also includes one pair of mounting tracks (351-0084-00).

TYPE R564B MOD 121N, MOD 171A OSCILLOSCOPE, without plug-in units **$1350**
(with CRT for stored display of highest intensity).

TYPE R564B MOD 121N, MOD 08, MOD 171A OSCILLOSCOPE, without plug-in units **$1**
(with CRT for fastest stored writing speed).

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

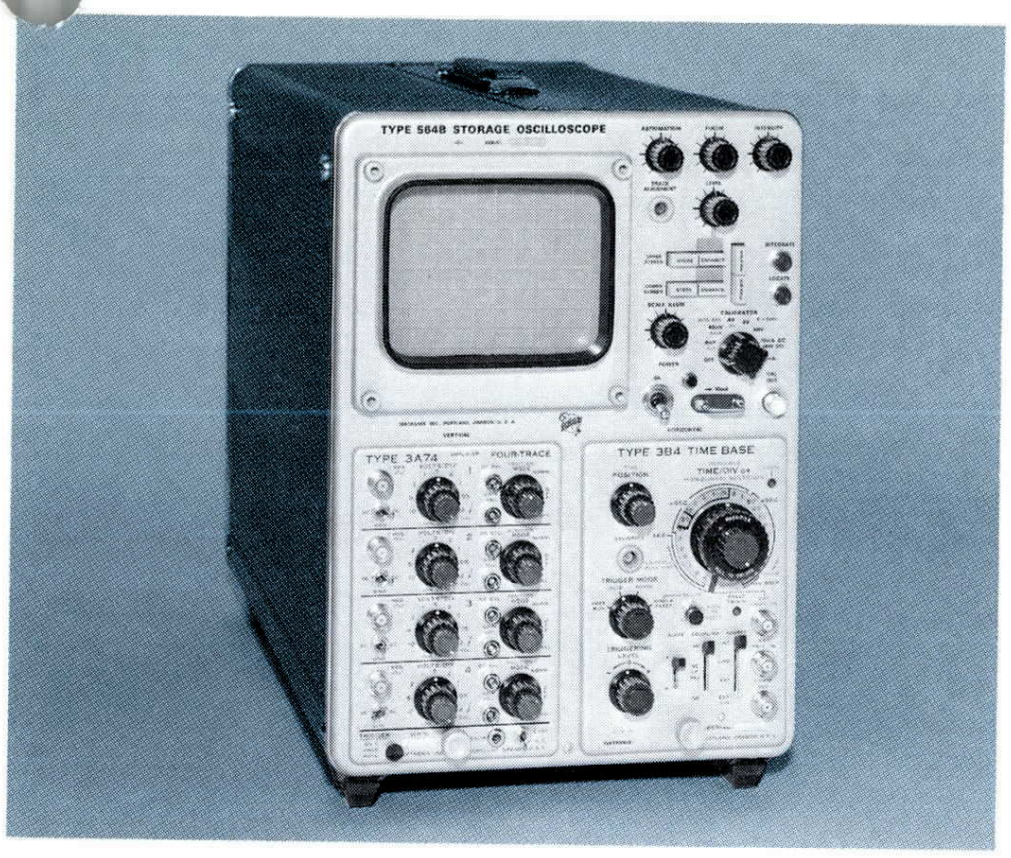
564B

Storage Oscilloscope

R564B

STORAGE OSCILLOSCOPE WITHOUT AUTO ERASE

Type 564B or R564B MOD 121N



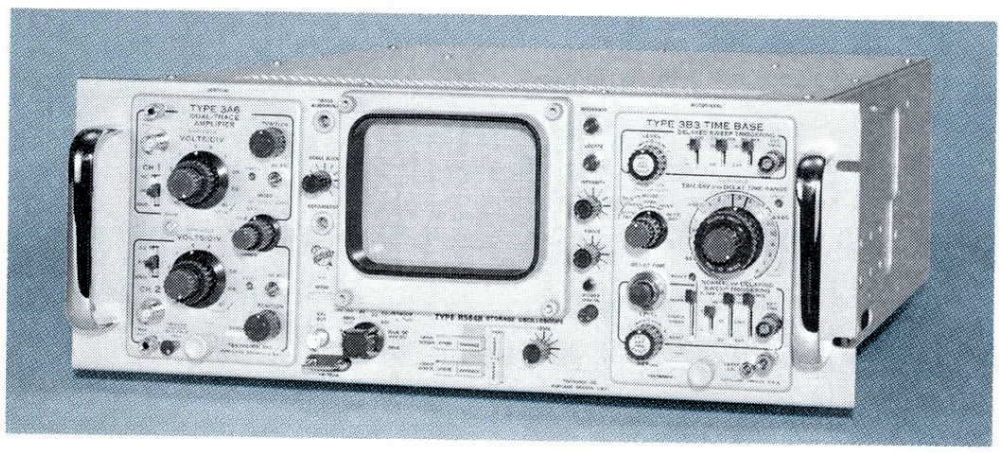
The auto erase and variable viewing time features of the Type 564B MOD 121N are deleted in the Type 564B and Type R564B. A cost savings is thus realized. All other storage characteristics, electrical characteristics and mechanical characteristics remain the same.

INCLUDED STANDARD ACCESSORIES FOR TYPE 564B

3- to 2-wire adapter (103-0013-00); BNC-post jack (012-0092-00); 18-inch patch cord (012-0087-00); 2 instruction manuals (070-0804-00).

TYPE 564B OSCILLOSCOPE, without plug-in units . **$1095**
(with CRT for stored display of highest intensity).

TYPE 564B MOD 08 OSCILLOSCOPE, without plug-in units **$1095**
(with CRT for fastest stored writing speed).



INCLUDED STANDARD ACCESSORIES FOR TYPE R564B

Mounting hardware (016-0131-00); BNC-post jack (012-0092-00); 18-inch patch cord (012-0087-00); 2 instruction manuals (070-0805-00).

TYPE R564B OSCILLOSCOPE, without plug-in units **$1145**
(with CRT for stored display of highest intensity).

TYPE R564B MOD 08 OSCILLOSCOPE, without plug-in units **$1145**
(with CRT for fastest stored writing speed).

TYPE R564B WITH SLIDE-OUT TRACKS

Type R564B MOD 171A or Type R564B MOD 08, MOD 171A mounts to a standard 19-inch rack on slide-out tracks. It can be pulled out, tilted, and locked in any one of seven positions for convenient servicing. Instrument has same standard accessories as the Type R564B, but also includes one pair of mounting tracks (351-0084-00).

TYPE R564B MOD 171A OSCILLOSCOPE, without plug-in units **$1195**
(with CRT for stored display of highest intensity).

TYPE R564B MOD 08, MOD 171A OSCILLOSCOPE, without plug-in units **$1195**
(with CRT for fastest stored writing speed).

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience.

PROBES

The probes recommended for use with these instruments are covered on the 2- and 3-Series Plug-In Unit pages Additional probes are available that may be better suited for a particular application, including current and high-voltage measurements. See the catalog accessory pages for information on these and other items.

CAMERAS

Standard C-12 with beam-splitting mirror for straight-on viewing and use of optional projected graticule; f/1.9—1:0.85 lens, Polaroid Land* Pack-Film back, order C-12 . . . . $490

Type 564B or R564B to C-12 Camera adapter, order 016-0217-00 . . . . . $ 16

Standard C-27 has rotating and removable viewing hood allowing mounting on adjacent Type R564B's f/1.9—1:0.85 lens, Polaroid Land* Pack-Film back, order C-27 . . . . $460

Type 564B or R564B to C-27 Camera adapter, order 016-0224-00 . . . . . $ 16

SCOPE-MOBILE® CART

Model 201-2 for Type 564B: two plug-in carrier, 9-position tilt-lock oscilloscope tray, order 201-2 . . . . . $155

SLIDE-OUT TRACKS

Converts standard Type R564B to R564B MOD 121N for easy withdrawal and tilt of instrument, order 351-0050-00 . . $ 50

CRADLE ASSEMBLY

Provides rear slide support when R564B with slide-out tracks is mounted in a backless rack, order 040-0344-00 . . . . $ 10

REMOTE-ERASE CONNECTOR

Mates with 9-pin connector on the rear panel of R564B supplied without cable, order 134-0049-00 . . . . . $4.70

*Registered Trademark Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon

Please refer to Terms and Shipment, General Information page.

561B Plug-In Oscilloscope R561B

- *ACCEPTS MULTI-TRACE, DIFFERENTIAL, SAMPLING AND SPECTRUM ANALYZER PLUG-IN UNITS*
- *8 x 10-cm DISPLAY*
- *ILLUMINATED PARALLAX-FREE GRATICULE*
- *X-Y DISPLAYS*
- *SOLID-STATE DESIGN*

The Tektronix Type 561B and Type R561B Oscilloscopes have a complete selection of plug-ins that permit changing measurement capabilities to meet changing measurement needs. Amplifier plug-ins offer a wide range of measurement capabilities with 10-MHz dual-trace plug-ins, 10 μV/div differential plug-ins, 25-ps sampling plug-ins and spectrum analyzer plug-ins covering the spectrum from 10 Hz to 36 MHz. Time-base plug-ins include delayed sweep, X50 magnifier, single time bases and sampling time bases. Two amplifier plug-ins may be used for X-Y or multiple X-Y displays. An automatic-seeking amplifier and time base are also available.

Both the Type 561B and the Type R561B use an 8 by 10-cm cathode-ray tube that features an internal graticule with controllable illumination. You can take photographs with the same ease, but without the parallax of an external graticule.

Occupying only 7 inches of rack height, the Type R561B bolts directly to the rack, but may be ordered with optional slide-out tracks at additional cost.

The Types 561B/R561B offer reliable operation with low-heat dissipation through the use of solid-state components.

CHARACTERISTIC SUMMARY

VERTICAL

Vertical deflection characteristics are extremely flexible through use of 2-Series and 3-Series Amplifier Plug-In Units including:

Dual trace—DC to 10 MHz, 35 ns.

Differential—DC to 1 MHz, 10 μV/div.

Sampling—DC to 14 GHz, 25 ps.

Spectrum Analyzer—10 Hz to 36 MHz.

HORIZONTAL

Horizontal deflection characteristics are extremely flexible through use of 2-Series and 3-Series Amplifier and Time-Base Units.

CRT

DISPLAY AREA—8 x 10 cm.

ACCELERATING VOLTAGE—3.5 kV.

PHOSPHOR—P31.

OTHER

CALIBRATOR—4 mV to 40 V ($\pm$1.5%), 1 kHz ($\pm$1%) squarewave and 40 V DC. Into 50.0 Ω, 2 mV, 20 mV and 200 mV squarewave. Current loop of 10 mA DC and 10 mA squarewave ($\pm$1.5%).

POWER REQUIREMENTS—90 V to 136 V or 180 V to 272 V, 48 Hz to 440 Hz (561B), 48 Hz to 66 Hz (R561B).

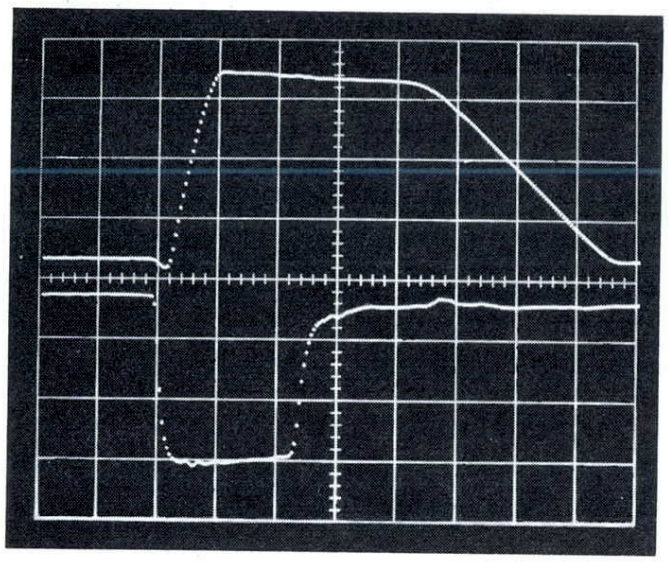
561B Plug-In Oscilloscope R561B

PARALLAX-FREE MEASUREMENTS—CONVENIENT PHOTOGRAPHY

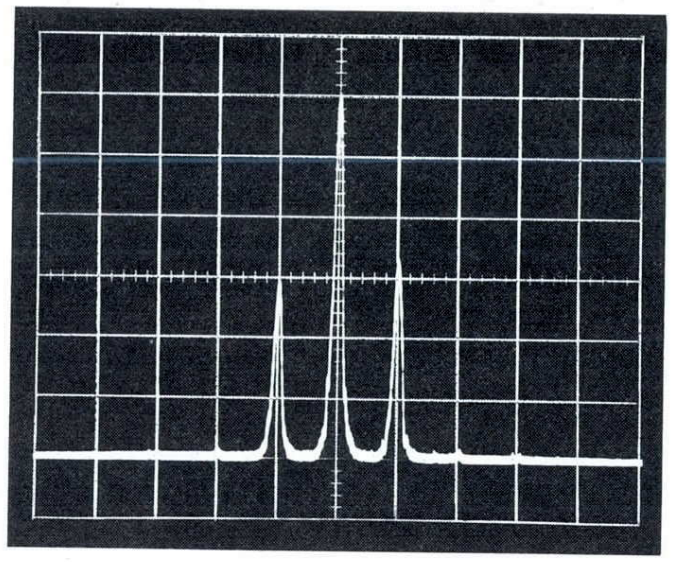
The internal graticule eliminates parallax, a common cause of erroneous readings. Parallax is an apparent displacement of the trace in relationship to the graticule. It occurs when the trace is on a different plane than the graticule and is not viewed from exactly the same angle for all parts of the display.

When the trace and graticule are on the same plane, as on the cathode-ray tube of the Type 561B and R561B Oscilloscope, parallax is eliminated.

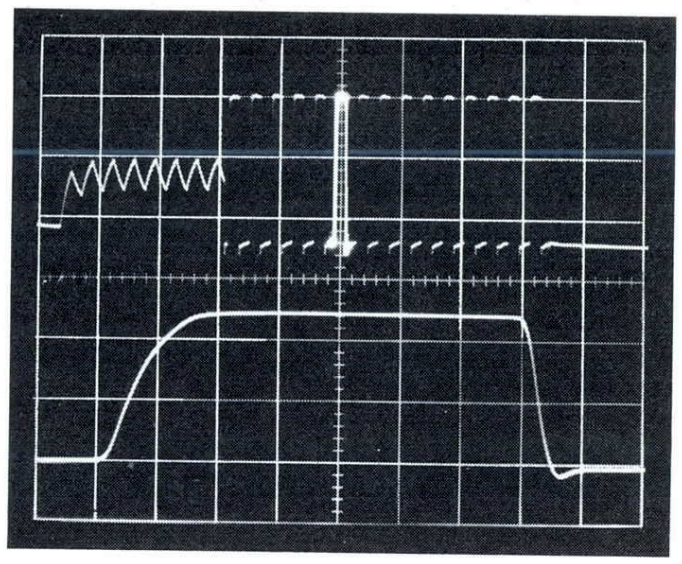
Controllable illumination of the internal graticule enables you to easily take waveform photographs in which the graticule rulings are sharply delineated. This was formerly possible only with oscilloscopes using external graticules.



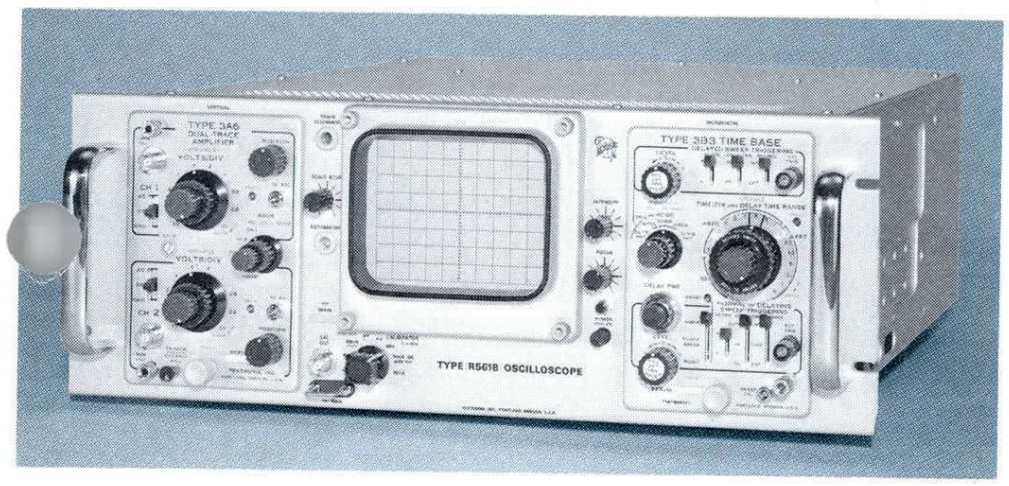
SAMPLING
Transistor turn-on and turn-off (upper trace). Driving pulse (lower trace).



SPECTRUM ANALYZER
Waveform showing center frequency and two sidebands.



DELAYING SWEEP (Double exposure)
Intensified portion of waveform (upper trace) expanded (lower trace) by means of delayed sweep.



TYPE 561B CHARACTERISTICS

PLUG-IN COMPARTMENTS

Accepts all 2-Series and 3-Series Amplifier and Time-Base Units except Type 3T6 and Type 3S6 Plug-Ins.

TEKTRONIX CRT

Flat-faced rectangular 5-inch tube with internal "no parallax" graticule, controllable edge-lighting, 3.5-kV monoaccelerator, beam deflection unblanking. A P31 Phosphor is normally supplied; P2, P7 or P11 are optional without extra charge. Consult your Field Engineer, Representative or Distributor for application information and availability.

ILLUMINATED INTERNAL GRATICULE

Edge lighted graticule marked in 8 vertical and 10 horizontal cm divisions. The centerlines are marked every 2 mm. Illumination is controlled by a front-panel knob.

DISPLAY CONTROLS

Front-panel controls include Focus, Astigmatism, Intensity and Scale Illumination (of the 8-cm by 10-cm display area), in addition to screwdriver adjustments for Trace Alignment.

Z-AXIS INPUT

Accessible through a BNC connector at the rear of the instrument permitting external modulation of the CRT cathode. Z-axis input is AC coupled to the CRT cathode and requires 10 V P-P for beam modulation at normal intensity.

AMPLITUDE CALIBRATOR

Front-panel selection of calibration signals. Voltage—4 mV, 40 mV, 400 mV, 4 V and 40 V ground-to-peak squarewave into 1 MΩ or greater; 40 V DC into 1 MΩ or greater; 2 mV, 20 mV or 200 mV ground-to-peak squarewave into 50.0 Ω. Current—Current loop of 10 mA DC or 10 mA ground-to-peak squarewave.

Voltage and current amplitude accuracy is within 1½% from +20°C to +30°C; within 2% from 0°C to +50°C.

Squarewave frequency is 1 kHz, within 1%. Risetime and falltime is 1 μs or less with load capacitance of 100 pF or less except in the 40-V position where t_r and t_f is 2.5 μs or less with load capacitance of 100 pF or less.

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature

Operating: 0°C to +50°C
Non-operating: −40°C to +65°C

Altitude

Operating: to 15,000 feet; maximum allowable ambient temperature decreased 1°C/1,000 feet from 5,000 to 15,000 feet.
Non-operating: to 50,000 feet.

Transportation

18-inch package drop. Cabinet model qualified under the National Safe Transit Committee Test procedure 1A.

DC-VOLTAGE SUPPLIES

All voltages required for proper operation of the oscilloscope and the plug-in units are regulated. Supplies operate normally with or without plug-ins.

POWER REQUIREMENTS

Quick-change, line voltage selection permits operation from any of the following voltages: 90 to 110 V, 104 to 126 V, 112 to 136 V, 180 to 220 V, 208 to 252 V, 224 to 272 V. The Type 561B will operate over a line-frequency range from 48 Hz to 440 Hz with a power consumption of 178 watts at 115 VAC, 60 Hz. The Type R561B will operate over a line frequency from 48 Hz to 66 Hz, with a power consumption of 186 watts at 115 VAC, 60 Hz.

TYPE 561B DIMENSIONS AND WEIGHTS

Height	14¾ in	37.5 cm
Width	9¾ in	24.8 cm
Depth	21½ in	54.7 cm
Net weight	32 lb	14.6 kg
Domestic shipping weight	≈41 lb	≈18.6 kg
Export-packed weight	≈53 lb	≈24 kg

TYPE R561B DIMENSIONS AND WEIGHTS

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Rack depth	20½ in	52.1 cm
Net weight	31¼ lb	14.2 kg
Domestic shipping weight	≈56 lb	≈25.4 kg
Export-packed weight	≈76 lb	≈34.4 kg

INCLUDED STANDARD ACCESSORIES FOR TYPE 561B

3- to 2-wire adapter (103-0013-00); BNC-post jack (012-0092-00); 18-inch patch cord (012-0087-00); 2 instruction manuals (070-0802-00).

INCLUDED STANDARD ACCESSORIES FOR TYPE R561B

Mounting hardware (016-0131-00); BNC-post jack (012-0092-00); 18-inch patch cord (012-0087-00); 2 instruction manuals (070-0803-00).

TYPE 561B OSCILLOSCOPE, without plug-in units . . **$595**

TYPE R561B OSCILLOSCOPE, without plug-in units . . **$645**

TYPE R561B WITH SLIDE-OUT TRACKS

Type R561B MOD 171A mounts to a standard 19-inch rack on slide-out tracks. It can be pulled out, tilted and locked in any one of 7 positions for convenient servicing. The instrument has the same standard accessories as the Type R561B, but also includes one pair of mounting tracks (351-0084-00).

TYPE R561B MOD 171A OSCILLOSCOPE, without plug-in units **$695**

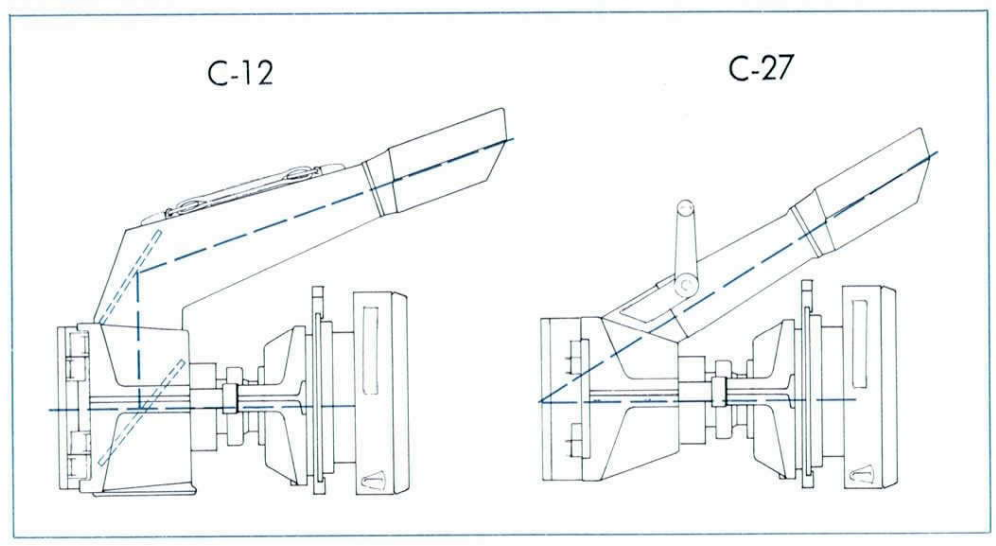
OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience.

PROBES

The probes recommended for use with these instruments are covered on the 2- and 3-series plug-in unit pages. Additional probes are available that may be better suited for a particular application, including current and high-voltage measurements. See the catalog accessory pages for information on these and other items.

CAMERAS



Standard C-12 with beam-splitting mirror for straight-on viewing and use of optional projected graticule; f/1.9—1:0.85 lens, Polaroid Land* Pack-Film back, order C-12 . . . . . $490

Type 561B or R561B to C-12 Camera adapter, order 016-0217-00 . . . . . $16

Standard C-27 has rotating and removable viewing hood allowing mounting on adjacent Type R561B's f/1.9—1:0.85 lens. Polariod Land* Pack-Film back, order C-27 . . . . . $460

Type 561B or R561B to C-27 Camera adapter, order 016-0224-00 . . . . . $16

SCOPE-MOBILE® CART

Model 201-2 for Type 561B: two plug-in carrier, 9-position tilt-lock oscilloscope tray, order 201-2 . . . . . $155

SLIDE-OUT TRACKS

Converts standard Type R561B for easy withdrawal and tilt of instrument, order 351-0050-00 . . . . . $50

CRADLE ASSEMBLY

Provides rear slide support when R561B with slide-out tracks is mounted in a backless rack, order 040-0344-00 . . . . . $10

*Registered Trademark Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

10-MHz Dual-Trace Amplifier

3A6

- ***35-ns RISETIME***
- ***TWO IDENTICAL CHANNELS***
- ***DC-to-10 MHz BANDWIDTH***
- ***10 mV/DIV-to-10 V/DIV CALIBRATED DEFLECTION FACTOR***

The Type 3A6 Amplifier is a general-purpose, dual-trace plug-in unit designed for use in the Types 561B, 564B and 565 Oscilloscopes. It can also be used in the Type 568/230 when digital readout is not required.

The Type 3A6 features two separate channels with identical characteristics. It can be operated in any one of five modes for a variety of single and dual-trace displays. Two Type 3A6's can be used for X-Y curve tracing, but without synchronized switching or channel pairing.

BANDWIDTH
DC to 10 MHz at 3-dB down. AC-coupled low-frequency response is 2 Hz, 0.2 Hz with 10X probe.

RISETIME
Approximately 35 ns.

DEFLECTION FACTOR
10 mV/div to 10 V/div in 10 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div.

INPUT RC
1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE
600 V combined DC + peak AC.

OPERATING MODES
Includes Channel 1 only (polarity of Channel 1 can be changed to provide 180° inversion); Channel 2 only; alternate—Channel 1 and 2 switched electronically on alternate sweeps; Chopped—successive 4 μs (approx) segments of each channel are displayed at an approx 125-kHz rate per channel (chopped transient blanking is provided); Added—outputs of Channel 1 and 2 added algebraically.

INTERNAL TRIGGER SIGNAL
Selectable from the output of Channel 1 only or from the combined output of the unit. Triggering from Channel 1 only permits viewing the true relationship between two signals when operating the unit in either alternate or chopped mode.

SIGNAL DELAY
Permits viewing of leading edge of fast-rise waveforms.*

WEIGHTS

Net weight	5¾ lb	2.6 kg
Domestic shipping weight	≈ 9 lb	≈4.1 kg
Export-packed weight	≈13 lb	≈5.9 kg

INCLUDED STANDARD ACCESSORIES
Two instruction manuals (070-0419-00).

TYPE 3A6 AMPLIFIER UNIT $550

OPTIONAL ACCESSORIES

The probes recommended for use with this instrument satisfy most measurement requirements. Additional probes are available that may be better suited for a particular application, including high-voltage and current measurements. See catalog accessory pages for information on these and other items.

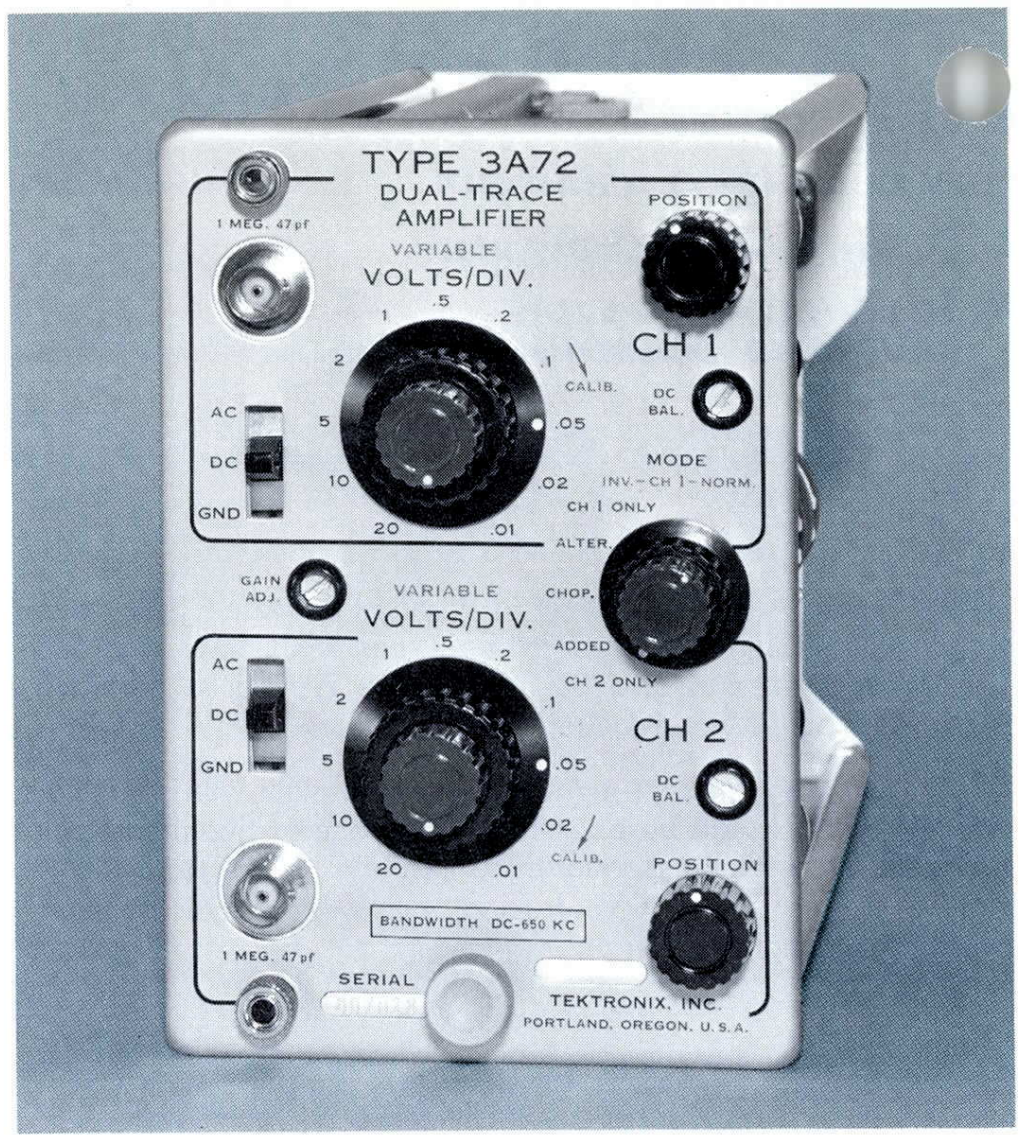
P6028 1X Probe Package, order 010-0074-00 ..... $16.50
P6006 10X Probe Package, order 010-0127-00 ..... $29.00
P6007 100X Probe Package, order 010-0150-00 ..... $29.00

**The Type 3A6 can be used with a Type 2B67 or Type 3B2 Time-Base Unit, but it will not usually be possible to view the entire leading edge of the triggering waveform. Same applies when the unit is used with Types 565 and RM565 Oscilloscopes.*

U. S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information Page.

650-kHz Dual-Trace Amplifier

3A72



- ***TWO IDENTICAL CHANNELS***
- ***10 mV/DIV-to-20 V/DIV CALIBRATED DEFLECTION FACTOR***

The Type 3A72 Amplifier is a general-purpose dual-trace plug-in unit that has two separate channels, each with identical characteristics. The unit can operate in any of five operating modes for a variety of single and dual-trace displays. This unit can be used in the Type 561B, Type 564B, or Type 565 Oscilloscope. It can also be used in the 568/230, but without digital presentation of the measurement.

BANDWIDTH

DC to 650 kHz at 3-dB down. AC-coupled low-frequency response is 2 Hz, 0.2 Hz with 10X probe.

DEFLECTION FACTOR

10 mV/div to 20 V/div in 11 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/div.

INPUT RC

1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE

600 V combined DC + peak AC.

OPERATING MODES

Includes Channel 1 only (normal or inverted); Channel 2 only; Alternate—Channel 1 and 2 switched electronically on alternate sweeps; Chopped—successive 16-μs segments of each channel are displayed at an approx 30-kHz rate per channel. Chopped transient blanking is provided; Added—outputs of Channel 1 and 2 algebraically added.

MULTIPLE X-Y DISPLAYS

Obtained with two Type 3A72 Plug-In Units; both synchronization and automatic pairing are provided. With two Type 3A72's operated in the dual-trace mode, Channel 1 of the left-hand unit is always plotted against Channel 1 of the right-hand unit.

WEIGHTS

Net weight	5 lb	2.3 kg
Domestic shipping weight	≈ 8 lb	≈3.6 kg
Export-packed weight	≈13 lb	≈5.9 kg

INCLUDED STANDARD ACCESSORIES

Two instruction manuals (070-0274-00).

TYPE 3A72 AMPLIFIER UNIT $310

OPTIONAL ACCESSORIES

The probes recommended for use with this instrument satisfy most measurement requirements. Additional probes are available that may be better suited for a particular application, including high-voltage and current measurements. See catalog accessory pages for information on these and other items.

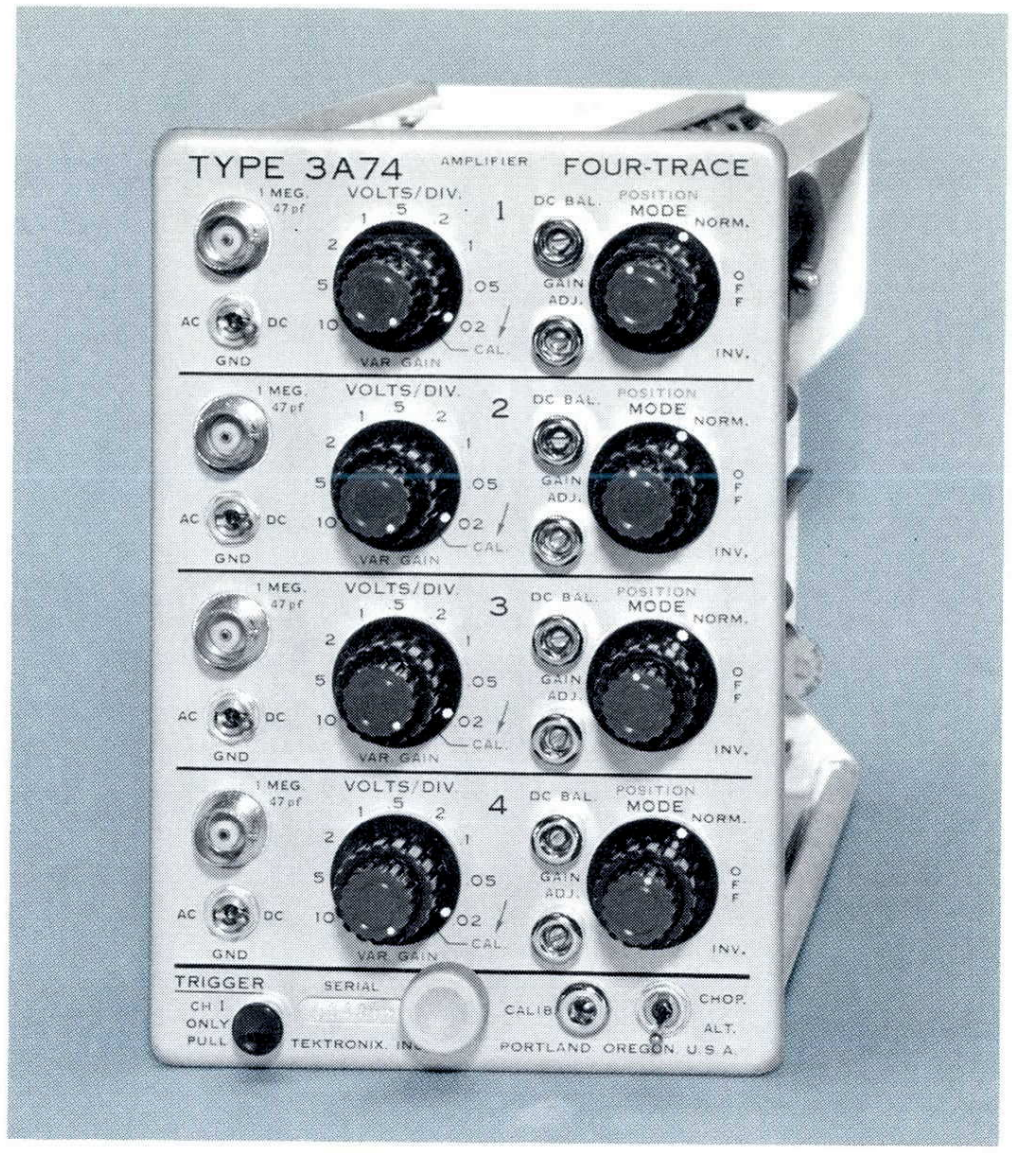
P6028 1X Probe Package, order 010-0074-00 ..... $16.50
P6006 10X Probe Package, order 010-0127-00 ..... $29.00
P6007 100X Probe Package, order 010-0150-00 ..... $29.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

2-MHz Four-Trace Amplifier

3A74

- ***FOUR SEPARATE CHANNELS***
- ***DC-to-2 MHz BANDWIDTH***
- ***20 mV/DIV-to-10 V/DIV CALIBRATED DEFLECTION FACTOR***



The Type 3A74 Amplifier is a general-purpose multi-trace plug-in unit that has four separate channels, each with identical characteristics. The unit can operate in a number of modes for a variety of single and multi-trace displays. The Type 3A74 can be used in the Type 561B, Type 564B or Type 565, and in the Type 568/230 Oscilloscope, but without digital presentation of the measurement.

BANDWIDTH

DC to 2 MHz at 3-dB down. AC-coupled low-frequency response is 2 Hz, 0.2 Hz with 10X probe.

RISETIME

Approximately 0.17 μs.

DEFLECTION FACTOR

0.02 V/div to 10 V/div in 9 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div.

INPUT RC

1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE

600 V combined DC + peak AC.

OPERATING MODES

Includes any one of the four channels separately (normal or inverted); Alternate—any combination of two or more channels switched electronically on alternate sweeps; Chopped — successive 2-μs segments of each channel are displayed at an approx rate per channel of: 250 kHz when using two channels; 167 kHz when using three channels; and 125 kHz when using four channels. Chopped transient blanking is provided.

MULTIPLE X-Y DISPLAYS

Obtained by using two Type 3A74 Plug-In Units; both synchronization and automatic pairing are provided. With two Type 3A74's, two, three or four independent displays may be obtained, properly paired: Channel 4 of the left-hand unit is always plotted against Channel 4 of the right-hand unit, Channel 3 versus Channel 3, etc.

INTERNAL TRIGGER SIGNAL (for the time-base)

From one of two sources as selected; either from the output of Channel 1 only or the combined output of the amplifier.

WEIGHTS

Net weight	6¼ lb	2.8 kg
Domestic shipping weight	≈10 lb	≈4.5 kg
Export-packed weight	≈14 lb	≈6.4 kg

INCLUDED STANDARD ACCESSORIES

Four BNC to binding-post adapters (103-0033-00); two instruction manuals (070-0347-01).

TYPE 3A74 AMPLIFIER UNIT $695

OPTIONAL ACCESSORIES

The probes recommended for use with this instrument satisfy most measurement requirements. Additional probes are available that may be better suited for a particular application, including high-voltage and current measurements. See catalog accessory pages for information on these and other items.

P6028 1X Probe Package, order 010-0074-00 ..... $16.50

P6006 10X Probe Package, order 010-0127-00 ..... $29.00

P6007 100X Probe Package, order 010-0150-00 ..... $29.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

1-MHz Amplifier

2A60

- ***DC-to-1 MHz BANDWIDTH***
- ***50 mV/DIV-to-50 V/DIV CALIBRATED DEFLECTION FACTOR***
- ***LOW COST***

The Type 2A60 is a general-purpose plug-in unit. It may be used in the Type 561B, Type 564B, Type 565, and in the Type 568/230 Oscilloscope, but without digital presentation of the measurement. Used with the Type 129 Power Supply, the Type 2A60 can drive recorders, X-Y plotters, oscilloscopes, and other indicators.

BANDWIDTH
DC to 1 MHz at 3-dB down. AC-coupled low-frequency response is 2 Hz, 0.2 Hz with 10X probe.

RISETIME
0.35 μs.

DEFLECTION FACTOR
0.05 V/div, 0.5 V/div, 5 V/div and 50 V/div. Calibrated accuracy within 3%. Uncalibrated, continuously variable between steps and to approx 500 V/div.

INPUT RC
1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE
600 V combined DC + peak AC.

WEIGHTS

Net weight	3 lb	1.4 kg
Domestic shipping weight	≈ 6 lb	≈2.7 kg
Export-packed weight	≈10 lb	≈4.5 kg

INCLUDED STANDARD ACCESSORIES
Two instruction manuals (070-0263-00).

TYPE 2A60 AMPLIFIER UNIT $140

OPTIONAL ACCESSORIES

The probes recommended for use with this instrument satisfy most measurement requirements. Additional probes are available that may be better suited for a particular application, including high-voltage and current measurements. See catalog accessory pages for information on these and other items.

P6028 1X Probe Package, order 010-0074-00 . . . . . $16.50

P6006 10X Probe Package, order 010-0127-00 . . . . . $29.00

P6007 100X Probe Package, order 010-0150-00 . . . . . $29.00

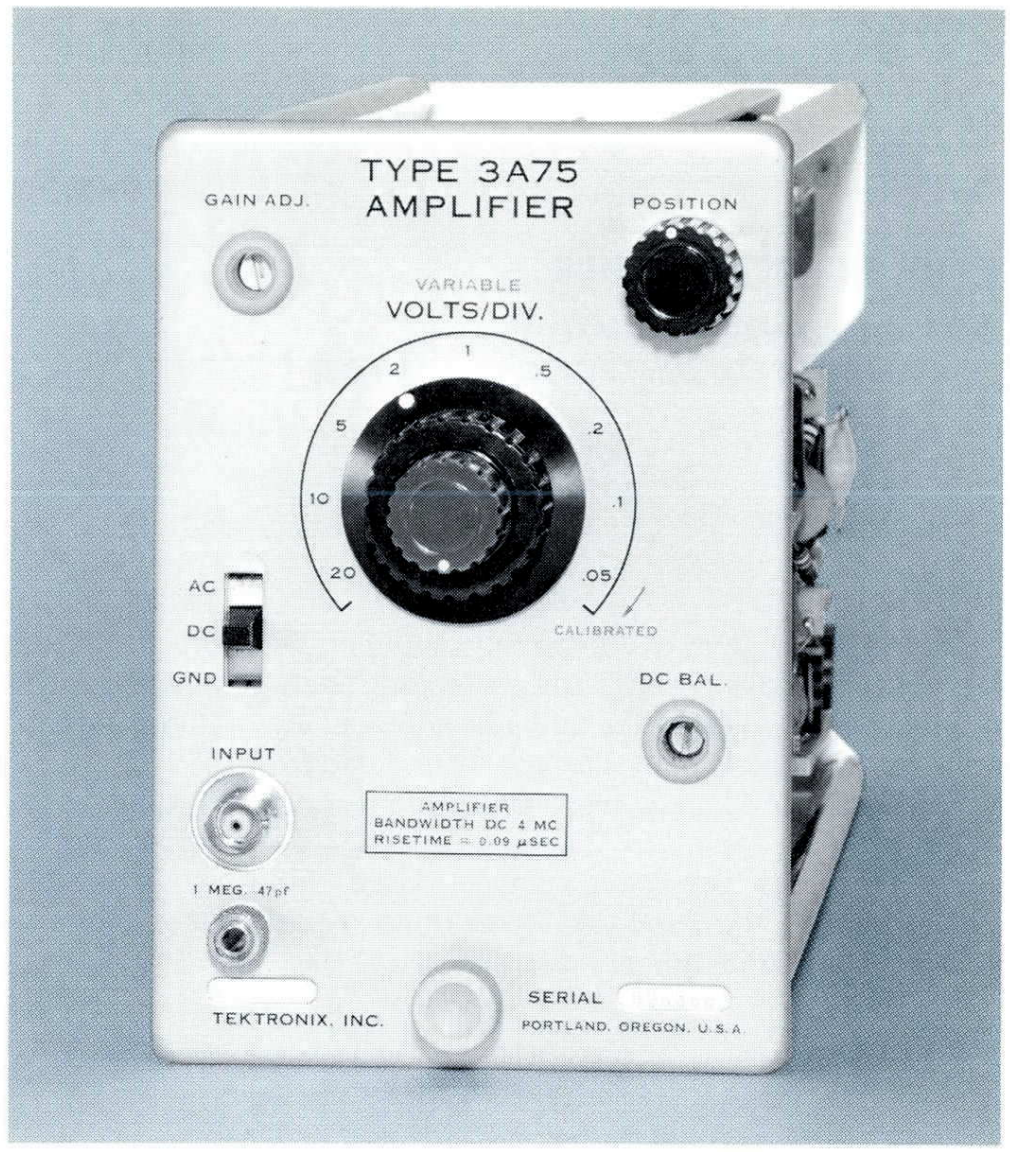
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

4-MHz Amplifier

3A75

- ***DC-to-4 MHz BANDWIDTH***
- ***50 mV/DIV-to-20 V/DIV CALIBRATED DEFLECTION FACTOR***

The Type 3A75 Amplifier is a general-purpose wide-band plug-in unit. It may be used in the Type 561B, Type 564B, Type 565, or in the Type 568/230 Oscilloscope, but without digital presentation of the measurement. Used with the Type 129 Power Supply, the Type 3A75 can drive recorders, X-Y plotters, oscilloscopes and other indicators.



BANDWIDTH
DC to 4 MHz at 3-dB down. AC-coupled low-frequency response is 2 Hz, 0.2 Hz with 10X probe.

RISETIME
Approximately 90 ns.

DEFLECTION FACTOR
50 mV/div to 20 V/div in 9 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/div.

INPUT RC
1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE
600 V combined DC + peak AC.

WEIGHTS

Net weight	3½ lb	1.6 kg
Domestic shipping weight	≈ 6 lb	≈2.7 kg
Export-packed weight	≈11 lb	≈5.0 kg

INCLUDED STANDARD ACCESSORIES
Two instruction manuals (070-0275-00).

TYPE 3A75 AMPLIFIER UNIT $215

OPTIONAL ACCESSORIES

The probes recommended for use with this instrument satisfy most measurement requirements. Additional probes are available that may be better suited for a particular application, including high-voltage and current measurements. See catalog accessory pages for information on these and other items.

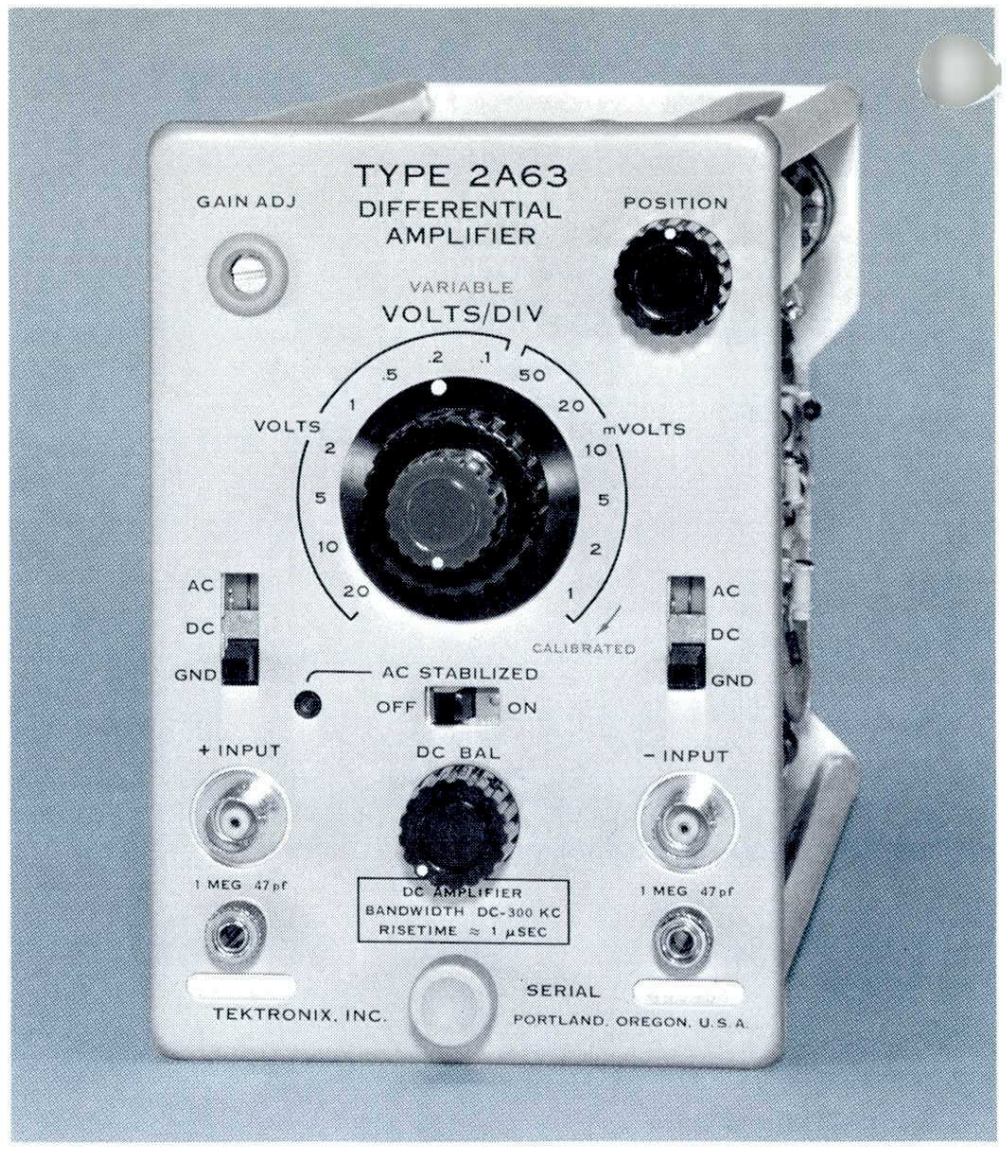
P6028 1X Probe Package, order 010-0074-00 . . . . . $16.50
P6006 10X Probe Package, order 010-0127-00 . . . . . $29.00
P6007 100X Probe Package, order 010-0150-00 . . . . . $29.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

1-mV Differential Amplifier

2A63

- ***UP TO 250:1 CMRR***
- ***1 mV/DIV-to-20 V/DIV CALIBRATED DEFLECTION FACTOR***



The Type 2A63 is a differential amplifier plug-in unit. It can be used to make voltage measurements between two above-ground points while at the same time cancelling in-phase signals such as hum pickup in the connecting leads.

The Type 2A63 may be used in the Type 561B, Type 564B, Type 565, or Type 568/230 Oscilloscope, but without digital presentation of the measurement. Used with the Type 129 Power Supply, the Type 2A63 can drive recorders, X-Y plotters, oscilloscopes, and other indicators.

BANDWIDTH

DC to 300 kHz at 3-dB down. AC-coupled low-frequency response is 2 Hz, 0.2 Hz with 10X probe.

RISETIME

$\leq$1.2 μs.

DEFLECTION FACTOR

1 mV/div to 20 V/div in 14 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/div.

INPUT RC

1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE

600 V combined DC + peak AC.

DIFFERENTIAL INPUT

DEFLECTION FACTOR	CMRR*	
	1 kHz	50 kHz
1 mV/cm to 50 mV/cm	250:1	150:1
0.1 V/cm to 20 V/cm	25:1	25:1

*With a maximum sinewave amplitude of 5 V P-P.

PHASE SHIFT

Phase shift between two Type 2A63 Units used for X-Y displays is nominally less than 1° at 50 kHz.

INTER-STAGE AC COUPLING

Reduces drift at high gain.

WEIGHTS

Net weight	3¾ lb	1.7 kg
Domestic shipping weight	≈ 7 lb	≈3.2 kg
Export-packed weight	≈11 lb	≈5.0 kg

INCLUDED STANDARD ACCESSORIES

Two instruction manuals (070-0266-00).

TYPE 2A63 AMPLIFIER UNIT $190

OPTIONAL ACCESSORIES

The probes recommended for use with this instrument satisfy most measurement requirements. Additional probes are available that may be better suited for a particular application, including high-voltage and current measurements. See catalog accessory pages for information on these and other items.

P6028 1X Probe Package, order 010-0074-00 ..... $16.50

P6023 10X Probe Package, adjustable attenuation helps maintain common-mode rejection, order 010-0167-00 $52.00

P6007 100X Probe Package, order 010-0150-00 ..... $29.00

U. S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information Page.

100-μV Dual-Trace Differential

3A3

- ***100 μV/DIV-to-10 V/DIV CALIBRATED DEFLECTION FACTOR***
- ***50,000:1 COMMON-MODE REJECTION***
- ***DC-to-500 kHz BANDWIDTH CONSTANT AT ALL DEFLECTION FACTORS***
- ***FET INPUTS***

The Type 3A3 Dual-Trace Differential Amplifier is designed for use in the Type 561B, 564B, 565, or in the 568/230 Oscilloscope, but without digital presentation of the measurement. Used in the Type 129 Power Supply, the unit can be used to drive X-Y plotters, oscilloscopes, and other indicators.

The Type 3A3 contains two independent, high-gain amplifier channels with identical characteristics. Either channel may be used to produce a display, or the two channels may be electronically switched to produce dual-trace displays. The unit features high sensitivity with direct-coupled inputs and has a high degree of common-mode rejection. A switch on the front panel selects the upper bandwidth limit of the unit, thus increasing the signal-to-noise-ratio.

BANDWIDTH

DC to >500 kHz at 3-dB down. Low-frequency 3-dB point is 2 Hz with AC coupling, 0.2 Hz with 10X probe. A BANDWIDTH switch selects high or low upper 3-dB points: DC to >500 kHz or DC to 5 kHz. Selected bandwidth is constant at all deflection-factor settings.

DEFLECTION FACTOR

100 μV/div to 10 V/div in 16 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div.

INPUT RC

1 megohm paralleled by approx 47 pF. Input R can be disconnected by removing internal wire link.

OPERATING MODES

Channel 1, Channel 2, or dual-trace with Alternate or Chopped switching. Chopping frequency is approx 200 kHz. Chopped transient blanking is provided.

DUAL X-Y DISPLAYS

Obtained with two Type 3A3 Plug-In Units. Dual-trace switching is synchronized, so that one Y-channel remains plotted against the same X-channel, once the display is set up. There is no provision for consistent pairing each time the system is operated.

COMMON-MODE REJECTION 0.1 mV/div to 10 mV/div Ⓐ		
Frequency	DC-Coupled	AC-Coupled
DC to 100 kHz	≥50,000:1	
100 kHz to 500 kHz	≥1,000:1	
15 Hz		≥500:1
60 Hz		≥2,000:1
20 mV/div to 10 V/div Ⓑ (Equal to, or adjustable to, the following minimum CMR ratios.)		
DC to 1 kHz	5,000:1	
1 kHz to 100 kHz	1,000:1	
100 kHz to 500 kHz	500:1	
15 Hz		≥500:1
60 Hz		≥2,000:1

Ⓐ For signals within + and —5 V of ground.

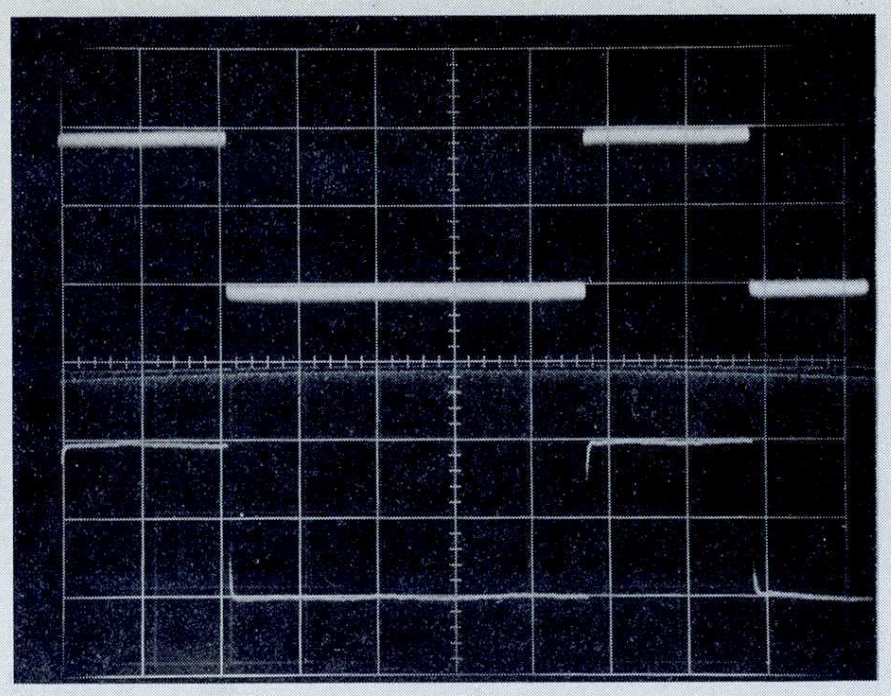
Ⓑ For signals within + and —50 V of ground from 20 mV/div to 0.1 V/div, and within + and —350 V of ground from 0.2 V/div to 10 V/div.

PHASE SHIFT

Less than 2° from DC to 100 kHz between two Type 3A3 Amplifiers used in X-Y operation. Phase shift can be adjusted to 0° at any particular deflection factor setting.

100-μV Dual-Trace Differential

3A3



Upper trace is a 200-μV pulse displayed at 100 μV/cm. Lower trace is the same signal showing significantly lower noise with the use of the bandwidth limiting switch (500 kHz vs 5 kHz).

NOISE

Displayed noise, tangentially measured, is less than 15 μV in the 500 kHz bandwidth position.

DRIFT

Less than 50 μV/°C.

INTERCHANNEL ISOLATION

Electrostatic Isolation is 10^6:1 or better referred to input signal levels. Dual-Trace Isolation in alternate or chopped operation is 100:1 or better referred to divisions of display. Example: 5 divisions displayed on channel 1 will cause no more than 0.05 divisions of deflection on channel 2.

TRIGGER PICKOFF

Internally coupled. Can be selected from Channel 1, Channel 2 or the composite signal after switching.

DIFFERENTIAL CF OUTPUTS

Output is available from two of the connector pins at the rear of the plug-in for use in driving recorders or other equipment. Output amplitude is a ground-reference, differential, ≈5-volt signal for each division of displayed signal. Front-panel TRIGGER SWITCH allows signal out selection of CH 1, CH 2 or composite. Bandwidth is DC to ≈400 kHz with a non-capacitive load. Jacks can be easily installed at the rear of the oscilloscope to provide access to the CF outputs.

WEIGHTS

Net weight	5¼ lb	2.4 kg
Domestic shipping weight	≈10 lb	≈4.5 kg
Export-packed weight	≈14 lb	≈6.4 kg

INCLUDED STANDARD ACCESSORIES

Four BNC-to-binding post adapters (103-0033-00); two BNC-to-BNC 18-inch patch cords (012-0087-00); two instruction manuals (070-0787-00).

TYPE 3A3 DUAL-TRACE DIFFERENTIAL AMPLIFIER . . $950

OPTIONAL ACCESSORIES

The probes recommended for use with this instrument satisfy most measurement requirements. Additional probes are available that may be better suited for a particular application, including high-voltage and current measurements. See catalog accessory pages for information on these and other items.

P6028 1X Probe Package, order 010-0074-00 ..... $16.50

P6023 10X Probe Package, adjustable attenuation ratio helps maintain common-mode rejection, order 010--0167-00 ..... $52.00

P6007 100X Probe Package, order 010-0150-00 ..... $29.00

P6006 10X Probe Package, order 010-0127-00 ..... $29.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

1-mV Differential Comparator

3A7

- ***1 mV/DIV-to-50 V/DIV CALIBRATED DEFLECTION FACTOR***
- ***UP TO 10-MHz BANDWIDTH***
- ***20,000:1 COMMON-MODE REJECTION***
- ***11,000-cm EFFECTIVE SCREEN HEIGHT***

The Type 3A7 High-Gain Differential Comparator adds to the measurement capabilities of Type 561B, 564B, and 565 Oscilloscopes. It can also be used in the 568/230, but without digital presentation of the measurement. Used with Type 129 Power Supply, the Type 3A7 can drive recording equipment, X-Y plotters, oscilloscopes, or other indicators.

As a differential input amplifier, the dynamic range of the 3A7 Unit permits common-mode signals up to ±15 volts in amplitude to be applied to the amplifier without attenuation. With a rejection ratio of about 20,000 to 1 for DC or low-frequency signals, differential signals of 1 mV or less on large common-mode signals can be measured. A front-panel attenuator permits the acceptance of common-mode voltages up to 500 V.

As a differential comparator, voltage measurements using the slide-back technique can be made with this unit. The high accuracy and stability of the DC comparison voltage, added differentially to the input signal, makes precise voltage measurements possible. Using this mode of operation, the 3A7 Unit has an effective screen height of ±11,000 cm. This is equivalent to a ±11-volt dynamic signal range at a deflection factor of 1 mV/cm. Within this range, calibrated ±DC comparison voltages can be added differentially to the input signal to permit a maximum of about 0.001% or 100 μV per mm to be resolved.

CALIBRATED DEFLECTION FACTOR

1 mV/div to 50 V/div, depending on millivolts/div and attenuator settings. Accuracy of millivolts/div positions is within 3%. Uncalibrated, continuous variation between steps and to approx 125 V/div.

BANDWIDTH (—3 dB)†		
mV/DIV	FREQUENCY	RISETIME
50 mV to 10 mV/div	DC to ≥10 MHz	≤35 ns
5 mV/div	DC to ≥ 8 MHz	≤44 ns
2 mV/div	DC to ≥ 6 MHz	≤58 ns
1 mV/div	DC to ≥ 4 MHz	≤88 ns

†Low-frequency 3-dB point, AC coupled: 2 Hz, 0.2 Hz with 10X probe.

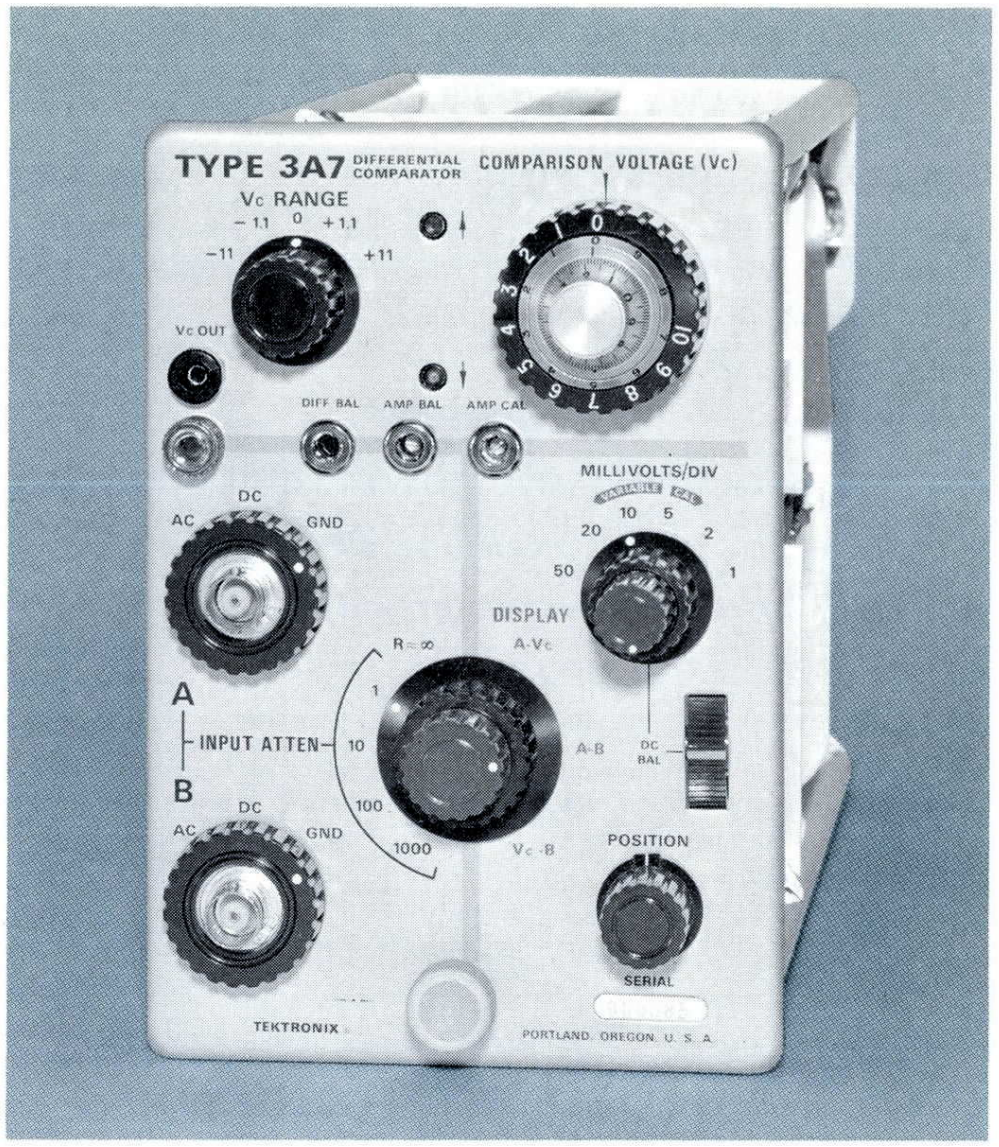
INPUT CHARACTERISTICS		
INPUT ATTEN	MAX PEAK INPUT VOLTS Common or Differential Mode	MAX INPUT ATTEN ERROR
R ≈ ∞	±15 V	*
1X	±15 V	**
10X	±150 V	±0.05%
100X	±500 V	±0.15%
1000X	±500 V	±3%

*Input R ≈ 10,000 to 50,000 MΩ.

**1X input R within ±0.1% of 10X input R.

INPUT RC

1 megohm paralleled by approx 20 pF.



COMMON-MODE REJECTION RATIO AT 1 mV/div	
DC COUPLED	≥20,000:1 with ±15 VDC or 30 V P to P AC, DC to 20 kHz
AC COUPLED	≥1000:1 with 30 V P to P at 60 Hz, to ≥20,000:1 at 20 kHz
HF (AC OR DC COUPLED)	≥500:1 with 30 V P to P at 500 kHz, to ≥20,000:1 at 20 kHz

COMPARISON VOLTAGE

0 to ±1.1 V, or 0 to ±11 V. Accuracy: ± (0.15% of indicated value plus 0.05% of V_c Range).

OVERDRIVE RECOVERY

Recovers to within 10 mV of reference signal within 300 ns after the signal returns to the screen. Certain overdrive signals can cause an additional slow (thermal) shift of up to 5 mV in the reference level.

WEIGHTS

Net weight	5¼ lb	2.4 kg
Domestic shipping weight	≈ 9 lb	≈4.1 kg
Export-packed weight	≈14 lb	≈6.4 kg

INCLUDED STANDARD ACCESSORIES

Two instruction manuals (070-0477-00).

TYPE 3A7 DIFFERENTIAL COMPARATOR $750

OPTIONAL ACCESSORIES

P6028 1X Probe Package, order 010-0074-00 ..... $16.50

P6023 10X Probe Package, adjustable attenuation ratio helps maintain common-mode rejection, order 010-0167-00 ..... $52.00

P6006 10X Probe Package, order 010-0127-00 ..... $29.00

P6007 100X Probe Package, order 010-0150-00 ..... $29.00

U. S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

10-μV Differential Amplifier

3A9

- ***VOLTAGE MEASUREMENTS***

  10 μV/div to 10 V/div

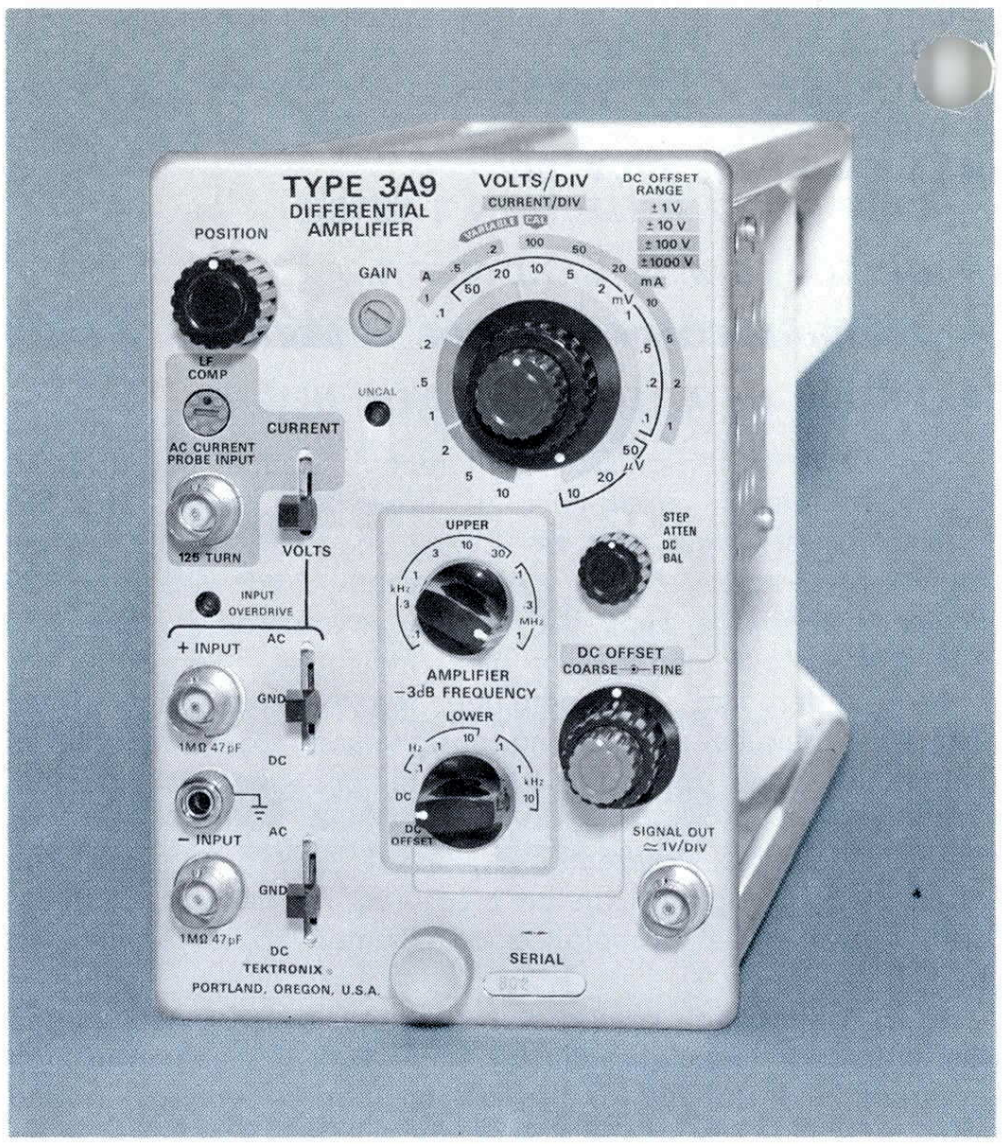
  DC-to-1 MHz BANDWIDTH

- ***CURRENT MEASUREMENTS (with optional current probe)***

  1 mA/div to 1 A/div

  10 Hz-to-1 MHz BANDWIDTH

- ***SELECTABLE UPPER AND LOWER 3-dB POINTS***
- ***100,000:1 COMMON-MODE REJECTION***
- ***INTERNAL DIFFERENTIAL DC OFFSET***
- ***10 μV/hour DC DRIFT****



CHARACTERISTICS

The Type 3A9 is a DC-coupled differential amplifier designed for use in Tektronix Type 560-Series Oscilloscopes, including the new Type 561B and Type 564B Storage Oscilloscopes. Used with the Type 129 Power Supply, the Type 3A9 can drive recorders, X-Y plotters, oscilloscopes and other indicators.

The Type 3A9 represents a significant improvement from previous performance standards in high-gain, differential, DC-coupled amplifiers for the Type 560-Series Oscilloscopes. DC drift is held to 10 μV/h, long term without chopper stabilization; displayed noise (tangentially measured) is 12 μV at 10 μV/div and 1-MHz bandwidth with a 25-Ω source resistance. Bandwidth is maintained at DC-to-1 MHz throughout the deflection factor range of 10 μV/div to 10 V/div. CMRR is at least 100,000:1 from DC-to-100 kHz from 10 μV/div to 10 mV/div. DC differential offset provides an internal voltage to cancel residual DC levels or to inspect signal components over a full differential dynamic range. Bandwidth is selectable at both upper and lower 3-dB points for noise attenuation and AC coupling at very low frequencies (0.1 Hz).

In addition, the Tektronix P6021 (125-turn) AC current probe provides the convenience of current readings from 1 mA/div to 1 A/div with the AC current probe input. The bandwidth when using the optional current probe is from 10 Hz to 1 MHz.

VOLTAGE CHARACTERISTICS

BANDWIDTH
DC-to-1 MHz independent of deflection factor setting.

FREQUENCY LIMITS— 3-dB POINTS
Upper—1 MHz, 300 kHz, 100 kHz, 30 kHz, 10 kHz, 3 kHz, 1 kHz, 300 Hz, 100 Hz.
Lower—DC, 0.1 Hz, 1 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz. A DC offset position provides DC low frequency response and turns on the DC offset control.

INPUT RC
1 megohm, paralleled by 47 pF.

*Constant ambient temperature and line voltage. See DC-drift specification.

DEFLECTION FACTOR
10 μV/div to 10 V/div in 19 calibrated steps, 1-2-5 sequence, accurate within 2%. Uncalibrated continuously variable between steps and to approximately 25 V/div.

INPUT COUPLING
May be switched to AC, GND or DC. Input coupling capacitor is automatically charged to proper voltage through a 1-megohm resistor when switch is in GND position. Lower —3-dB point is approximately 1.6 Hz when AC coupled at input.

INPUT GATE CURRENT
From 10 μV/div to 10 mV/div, maximum input gate current is $\pm$20 pA at +25°C and $\pm$100 pA at +50°C; 20 mV/div to 10 V/div, maximum input gate current is $\pm$10 pA at +25°C and $\pm$10 pA at +50°C. Display shift at 10 μV/div (+25°C, AC coupled) is $\pm$2 div.

DISPLAYED NOISE
$\leq$12 μV or 0.1 div, whichever is greater, measured tangentially at full bandwidth (1 MHz), source resistance 25 Ω or less.

DC DRIFT
Drift with time (constant ambient temperature and line voltage; DC to 100 Hz bandwidth).

Short term: $\leq$5 μV/min (P-P) or 0.1 div (whichever is greater) after 1-hour warm up.

Long term: $\leq$10 μV/h (P-P) or 0.1 div (whichever is greater) after 1-hour warm up.

Drift with ambient temperature change (line voltage constant) is $\leq$50 μV/°C.

10-μV Differential Amplifier

3A9

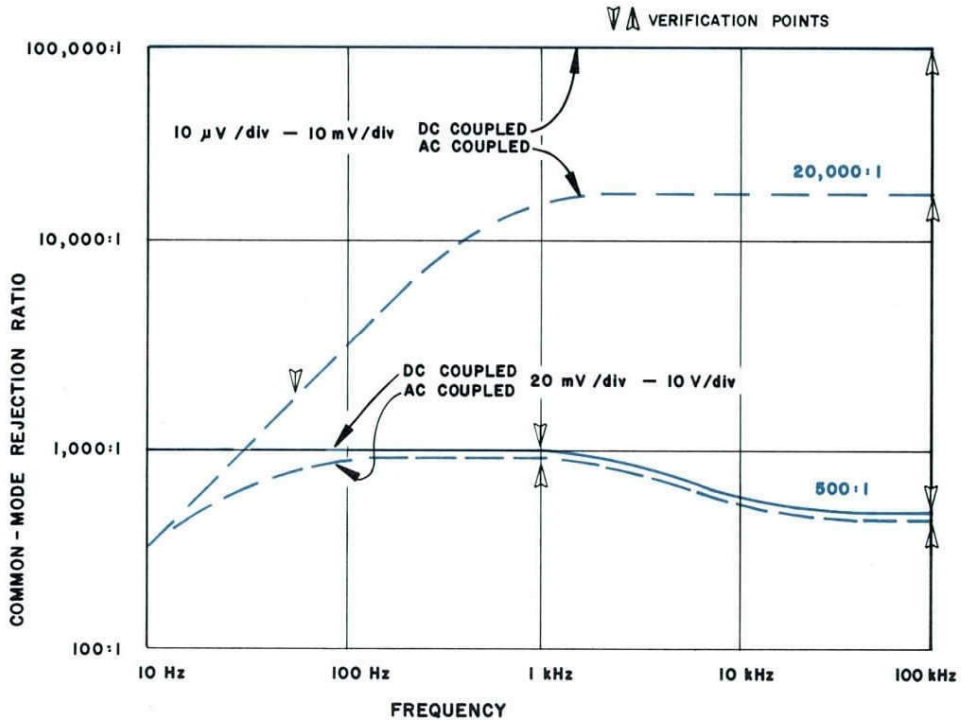
DIFFERENTIAL DYNAMIC RANGE

10 μV/div to 10 mV/div—±1 V.
20 mV/div to 0.1 V/div—±10 V.
0.2 V/div to 1 V/div—±100 V.
2 V/div to 10 V/div—±1000 V (500 V max each input).

DC OFFSET

10 μV/div to 10 mV/div—+1 V to —1 V.
20 mV/div to 0.1 V/div—+10 V to —10 V.
0.2 V/div to 1 V/div—+100 V to —100 V.
2 V/div to 10 V/div—+1000 V to —1000 V.

COMMON-MODE REJECTION



COMMON-MODE DYNAMIC RANGE

10 μV/div to 10 mV/div—±10 V.
20 mV/div to 0.1 V/div—±100 V.
0.2 V/div to 10 V/div—±500 V.

MAXIMUM INPUT VOLTAGE

DC Coupled: 10 μV/div to 10 mV/div—±15 V (DC + peak AC);
20 mV/div to 10 V/div—±500 V (DC + peak AC).

AC-Coupled Input DC Voltage: ±500 V, each input.

OVERDRIVE RECOVERY

≤10 μs to recover to within 0.5% of zero level after removal of a + or — voltage applied for 1 s. Voltage not to exceed differential dynamic range.

INPUT OVERDRIVE LIGHT

Indicates differential overload is being approached.

AC CURRENT CHARACTERISTICS WITH OPTIONAL CURRENT PROBE

BANDWIDTH

10 Hz to 1 MHz with optional AC current probe.

FREQUENCY LIMITS—3-dB POINTS

Upper—1 MHz, 300 kHz, 100 kHz, 30 kHz, 10 kHz, 1 kHz, 300 Hz, 100 Hz.
Lower—10 kHz, 1 kHz, 100 Hz. Not calibrated from 10 Hz to DC.

INPUT

Accepts Tektronix P6021 (125-turn) AC current probe.

DEFLECTION FACTOR

1 mA/div to 1 A/div in 10 calibrated steps, 1-2-5 sequence accurate within 3%. Uncalibrated continuously variable between steps and to approximately 2.5 A/div.

MAXIMUM INPUT CURRENT

10 A P-P.

FRONT-PANEL SIGNAL OUTPUT

1 V (±20%) per displayed division. DC coupled, internally adjustable to ground reference. Dynamic range is at least +5 V to —5 V. Bandwidth is DC to at least 500 kHz. Output resistance is 100 Ω or less. Minimum load resistance, 10 kΩ.

WEIGHTS

Net weight	4¾ lb	2.2 kg
Domestic shipping weight	≈ 8 lb	≈3.6 kg
Export-packed weight	≈12 lb	≈5.4 kg

INCLUDED STANDARD ACCESSORIES

Two instruction manuals (070-0913-00).

TYPE 3A9 PLUG-IN UNIT $525

OPTIONAL ACCESSORIES

The probes recommended for use with this plug-in unit satisfy most measurement requirements. Other probes are available. See the Tektronix Catalog accessory pages for additional information on these and other items.

P6023 10X Probe Package, adjustable attenuation ratio helps maintain common-mode rejection, order 010-0167-00 $52.00
P6028 1X Probe Package, order 010-0074-00 ..... $16.50
P6007 100X Probe Package, order 010-0150-00 ..... $29.00
P6021 Current Probe, order 010-0237-02 ..... $94.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Operational Amplifier

3A8

- ***TWO OPERATIONAL AMPLIFIERS***
- ***10 MHz OR GREATER GAIN-BANDWIDTH PRODUCT***
- ***15,000 OR GREATER OPEN-LOOP GAIN***
- ***SELECTABLE INTERNAL Z_i AND Z_f COMPONENTS***
- ***PROVISION FOR EXTERNAL Z_i AND Z_f COMPONENTS***

The Type 3A8 Operational Amplifier performs precise integration, differentiation, function generation, linear and nonlinear amplification. The unit can be used in the Type 561B, 564B, or Type 565. It can also be used in the Type 568/230, but without digital presentation of the measurement. Signals from the operational amplifiers can be displayed on the oscilloscope and/or fed to other devices.

Used with the Type 129 Power Supply, the Type 3A8 can drive recorders, X-Y plotters, oscilloscopes, and other indicators.

DISPLAY AMPLIFIER

BANDWIDTH
DC to $\geq$3.5 MHz at 3-dB down.

RISETIME
$\leq$100 ns.

DEFLECTION FACTOR
20 mV/div to 10 V/div in 9 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to opprox 25 V/div.

INPUT RC
1 megohm paralleled by 47 pF.

OPERATING MODES
Signal source selection from either operational amplifier or an external signal. AC or DC coupling. The display can be inverted to provide the desired deflection polarity.

OPERATIONAL AMPLIFIERS

OPEN-LOOP GAIN
$\geq$15,000 at DC.

OPEN-LOOP GAIN-BANDWIDTH PRODUCT
$\geq$10 MHz.

OUTPUT RANGE
$\pm$25 V, $\pm$7.5 mA. Protected against shorts to ground.

OUTPUT IMPEDANCE
$\leq$30 Ω at 1 MHz for compensated unity-gain amplifier.

INPUT OFFSET
Voltage: adjustable to zero $\pm$500 μV (front-panel control).

Current: adjustable to zero $\pm$50 pA (calibration control).

DRIFT
After 30 minute warmup, typically $<$0.5 mV/hour referred to input (averaged over 10 hours).

FEEDBACK
Provisions for negative and/or positive feedback. Negative feedback utilizes internal and/or external impedances; positive feedback utilizes external impedances only.

SELECTABLE INPUT AND FEEDBACK COMPONENTS
Front-panel switches allow independent selection of the following resistors and capacitors in any combination as Z_i and Z_f: 0.01, 0.1, 0.2, 0.5 and 1 megohm; 10 pF, 100 pF, 0.001, 0.01, 0.1 and 1 μF. All values are $\pm$1% except 10 pF and 100 pF which are adjustable.

INTEGRATION LOW-FREQUENCY REJECT
An RC network which prevents integration below approx 2 Hz (voltage or current offset drift) can be switched in or out as needed. Other networks can be connected externally.

TERMINAL ADAPTERS

Two shielded terminal adapters are included for construction of external circuitry for custom applications. Over one hundred suggested circuits for special applications are shown in the instruction manual.

WEIGHTS

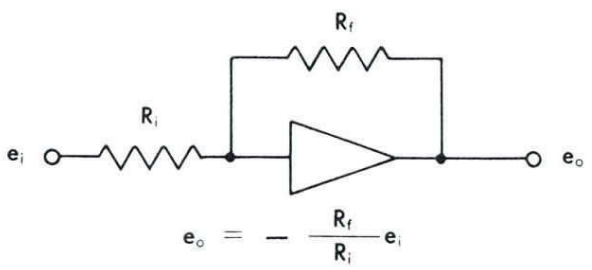
Net weight	4½ lb	≈2.0 kg
Domestic shipping weight	≈9 lb	≈4.1 kg
Export-packed weight	≈13 lb	≈5.9 kg

INCLUDED STANDARD ACCESSORIES

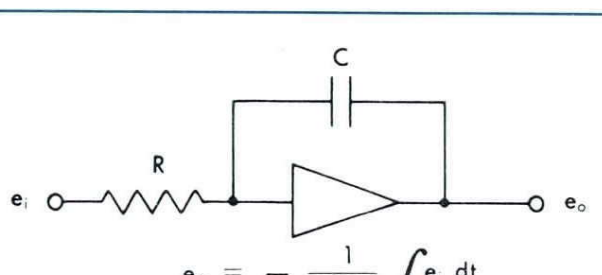
Two terminal adapters (013-0048-01); two terminal shields (013-0049-01); two BNC to binding post adapters (103-0033-00); two instruction manuals (070-0507-00).

TYPE 3A8 OPERATIONAL AMPLIFIER UNIT $715

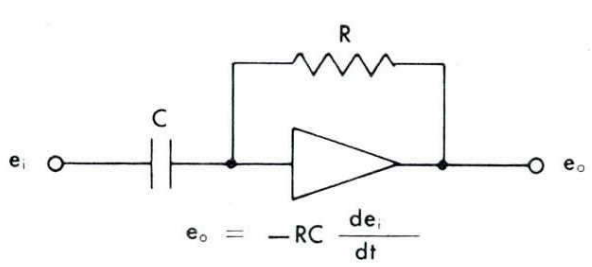
BASIC OPERATING MODES



AMPLIFICATION is determined by the ratio of R_f to R_i due to the high open-loop gain. This provides convenient signal step-up or step-down with low output impedance. External compensation extends the closed-loop gain-bandwidth (see Compensating Adapter).

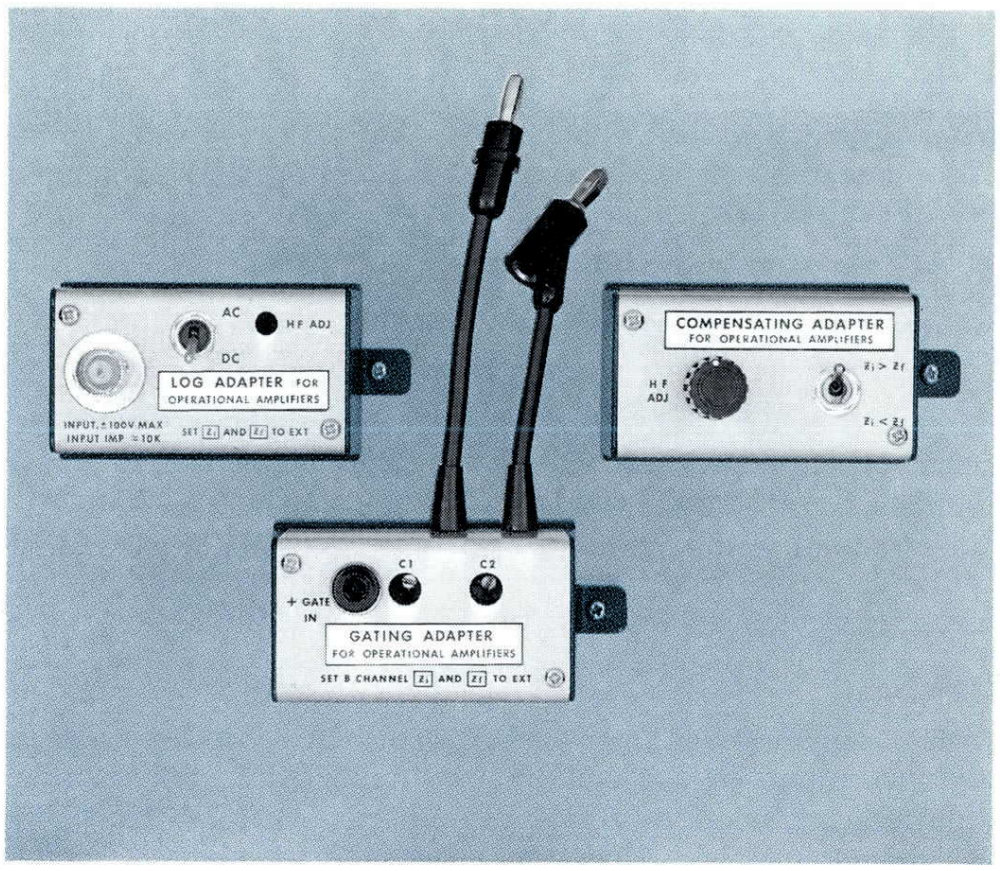


INTEGRATION is obtained by placing a capacitor in the feedback loop. Unlike the passive RC integrator, this circuit permits output loading. Typical applications include magnetic core B-H loop studies.



DIFFERENTIATION is accomplished by placing a capacitor in the input circuit. The unique characteristic of this circuit is the extraction of higher frequency signal components without loss of signal level. It can detect minute information such as transients and slope changes.

OPTIONAL ACCESSORIES



COMPENSATING ADAPTER

For extending the high-frequency performance of either operational amplifier when the internal Z_i and Z_f resistors are used in any combination for gain or attenuation. The adapter compensates for stray capacitance associated with the internal resistors, providing an adjustment for optimum HF response. Order Part Number 013-0081-00 ..... $39

LOG ADAPTER

Mixed low- and high-amplitude signals can be measured using the Log Adapter. Pulses and transient waveforms spanning three voltage decades to plus 100 volts or minus 100 volts can be displayed and measured on the same trace. Order Part Number 013-0067-00 ..... $83

GATING ADAPTER

The Gating Adapter allows integration and display of repetitive signals by resetting the integrator to zero during sweep retrace time. The adapter uses Operational Amplifier "2" of the Type 3A8 to gate amplifier "1" on and off in response to an external gating signal, such as the +Gate signal from a Type 3B4 Time Base Plug-In Unit. The signal applied to amplifier "1" is then amplified, integrated, or differentiated only during the "on" time. Order Part Number 013-0068-00 ..... $83

PROBES

The probes recommended for use with the display amplifier of the Type 3A8 satisfy most measurement requirements. Additional probes are available that may be better suited for a particular application including high-voltage and current measurements. See accessory pages at the rear of the catalog for information on these and other items.

P6028 1X Probe Package, order 010-0074-00 ..... $16.50
P6006 10X Probe Package, order 010-0127-00 ..... $29.00
P6007 100X Probe Package, order 010-0150-00 ..... $29.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Carrier Amplifier

3C66

- ***HIGH GAIN***
- ***LOW NOISE***
- ***ESSENTIALLY DRIFT FREE***
- ***RECORDER OUTPUT***

The Type 3C66 Carrier Amplifier with suitable transducer measures mechanical quantities that can be converted to a change in resistance, capacitance, or inductance. This unit may be used in the Type 561B, Type 564B, Type 565, or in the 568/230 Oscilloscopes, but without digital presentation of the measurement. Used with the Type 129 Power Supply, the Type 3C66 can drive recorders, X-Y plotters, oscilloscopes, and other indicators.

The gap between mechanical engineering and electronic instrumentation is bridged with the Type 3C66 and suitable transducers. The total range of applications is as broad as the mechanical field itself and includes stress analysis, vibration studies, and fatigue tests. Typical quantities measured are force, displacement, acceleration, and strain.

The Type 3C66 operates on an AC carrier principle. It uses an AC bridge at the input to convert transducer signals into an amplitude-modulated carrier signal. The carrier signal is amplified by a high-gain AC amplifier and then demodulated to obtain the CRT deflection voltages.

BANDWIDTH

DC to 5 kHz at 3-dB down.

RISETIME

Approximately 70 μs.

CALIBRATED DEFLECTION FACTOR

10 microstrain/div (micro-inches per inch/div) to 10,000 microstrain/div when the Type 3C66 is used with a single strain gage having a gage factor of approximately 2. Uncalibrated continuous control from 10 microstrain/div to 25,000 microstrain/div. Attenuator accuracy, when set accurately in any one step, is within 2% on all other steps.

AMPLIFIER INPUT

Input is to an AC bridge with 25-kHz excitation voltage. One or more of the four bridge arms can have transducers attached to them. Total bridge voltage is approximately 5 V RMS, regulated.

NOISE

Typically equivalent to an input of 2.0 microstrain (peak to peak) at maximum calibrated sensitivity. This approximates an RMS noise of 0.5 microstrain.

DRIFT

Drift of the over-all system is primarily a function of the transducer stability. The Type 3C66 Amplifier system is essentially drift free.

GAGE FACTORS

Factors from 1 to 6 are usable without changing the steps of the sensitivity control. The range of factors is compensated for by adjusting the Gain Adjust Control.

EQUIVALENT DC SENSITIVITY

A comparable DC amplification system would require approximately 10 microvolts/div sensitivity for the same amount power applied to the Type 3C66.

CAPACITIVE TRANSDUCERS

Used in conjunction with a four-arm resistive bridge results in the following maximum useful sensitivities: 120-ohm bridge, 1 pF/div; 1000-ohm bridge, 0.2 pF/div; useful sensitivities are slightly lower when using long cables.

INDUCTIVE TRANSDUCERS

Must have characteristics compatible with the 25-kHz carrier frequency to function properly. Linear-variable-differential transformers designed for nominal carrier frequencies of 2 kHz and higher usually operate satisfactorily without additional circuitry.

RECORDER SIGNAL OUTPUT

DC coupled with an output of about 3 V for each major division of CRT display. DC level is adjustable to 0 V by an internal control.

WEIGHTS

Net weight	5 lb	2.3 kg
Domestic shipping weight	≈ 9 lb	≈4.1 kg
Export-packed weight	≈14 lb	≈6.4 kg

INCLUDED STANDARD ACCESSORIES

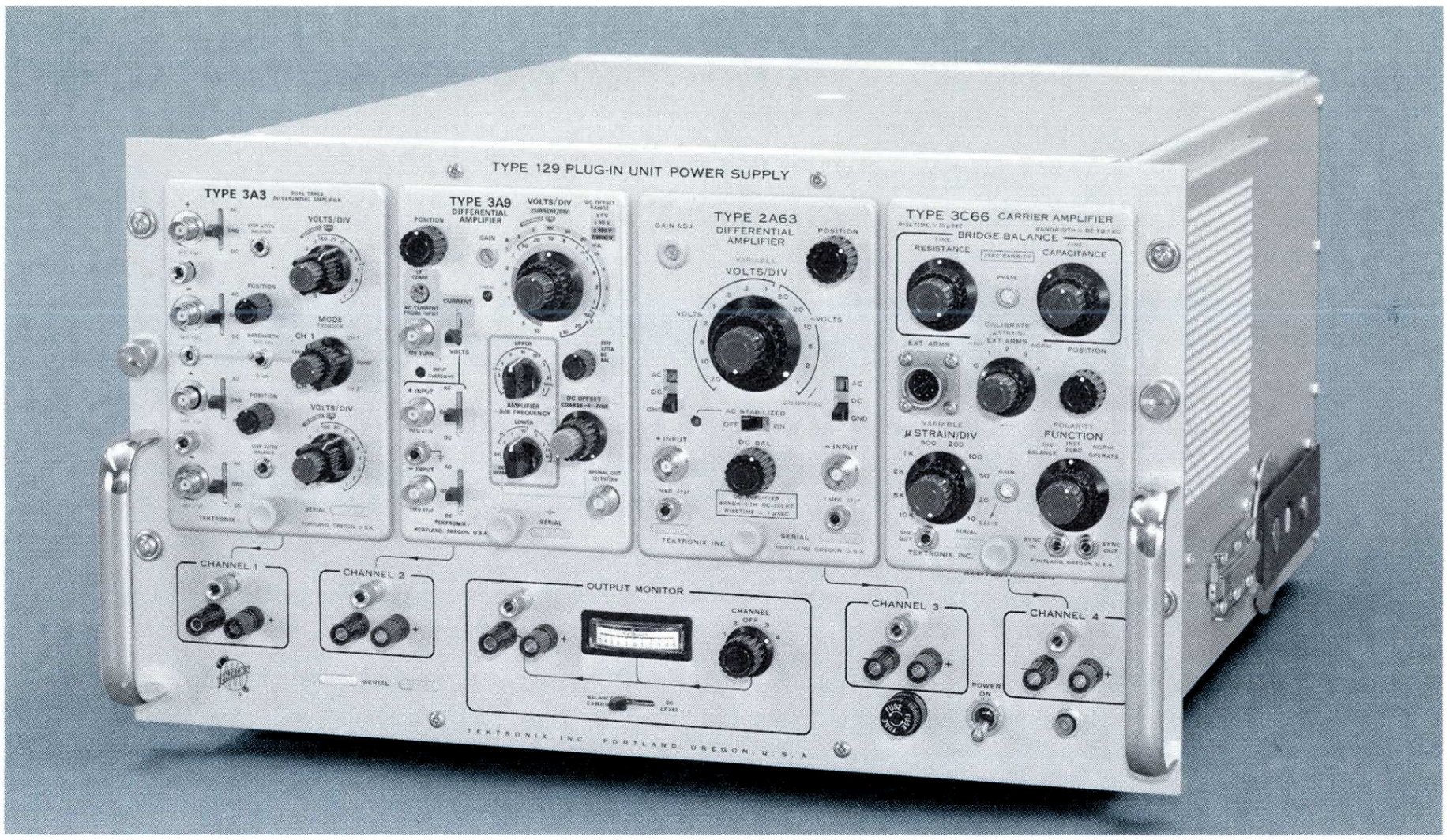
Synchronizing cable, RG174/U (012-0063-00); 4-wire 15-ft shielded connector cable (012-0040-00); two instruction manuals (070-0357-00).

TYPE 3C66 AMPLIFIER UNIT $525

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Power Supply For Plug-In Units

129



- ***SINGLE-ENDED OR DIFFERENTIAL VOLTAGE OUTPUTS***
- ***OPERATES UP TO FOUR PLUG-IN UNITS***

The Type 129 Plug-In Supply provides a method of utilizing 2- and 3-Series Amplifier and Time Base Plug-In Units in a wide variety of instrumentation systems. With this power supply, the amplifiers can be used to drive recording equipment, X-Y plotters, oscilloscopes, or other external indicators having requirements within the plug-in unit specifications. The unit is designed to mount in a standard 19-inch rack.

The Type 129 is recommended for use with the 2- and 3-Series single channel low-frequency amplifiers. Multiple-trace plug-ins are usable in the Type 129, but operation should be limited to single-trace modes unless provision is made to operate the multiple-trace switching circuits at a relatively slow rate compatible with the output-circuit bandwidth.

The Type 129 powers up to four 2- and 3-Series plug-in units*, singly or in combination. Each plug-in unit fits into a plug-in compartment having an output connector at the front and rear panels. A selectable cathode-follower or passive circuit card, placed between the plug-in unit and the output connector, controls the output characteristics. All plug-in units that do not have a signal-out provision on the front panel must use one of these cards in order to function properly. Plug-in units with signal-output connectors on the front panel can be used with or without circuit cards.

With the cathode-follower plug-in circuit card installed, push-pull, low impedance signals (to approximately 8 V peak to peak) are available via cathode followers at front and rear connectors. An automatic DC level-setting circuit keeps the average DC level of the two connectors close to 0 V. Bandwidth of the cathode-follower output circuit is DC to approximately 1 MHz.

With the passive card installed, a high-impedance push-pull signal is available at the front panel for balancing and a single-ended signal at low impedance (approximately 500 ohms) is available at the rear output connector. Bandwidth of the passive divider output circuit is DC to approximately 100 kHz and is dependent upon the plug-in used.

Each output can be switched to a meter for DC balance indication. This allows quick setting of the plug-in position control. In addition to the output monitor switch, a two-position switch has been included for balancing of the Type 3C66 Carrier Amplifier Plug-In Unit.

**Sampling plug-ins, designed to operate in pairs (one vertical and one sweep), and Spectrum Analyzer or Automatic "Seeking" plug-ins designed to operate in conjunction with another 2 or 3-Series plug-in, must be "paired up" in Channels 1 and 2 or 3 and 4.*

Power Supply For Plug-In Units

129

TYPICAL APPLICATIONS				
PLUG-IN TYPE	INDICATED DEFLECTION FACTOR	APPROXIMATE SYSTEM GAIN		
		With Passive Output Card*	With CF Output Card**	
			Single Ended	Push-Pull
2A60	50 mV/div	50	20	40
2A63	1 mV/div (DC)	2.5×10^3	10^3	2×10^3
3A3	100 μV/div	2.5×10^4	10^4	2×10^4
3A9	10 μV/div (DC)	2.5×10^5	10^5	2×10^5
3A75	50 mV/div	50	20	40
3C66	10 μstrain/div	0.25 V/μstrain	0.1 V/μstrain	0.2 V/μstrain
3L5	To be used with any 2 or 3-Series Time Base to provide 10 Hz-to-1 MHz Spectrum Analysis.			
	1 mV/div	2.5×10^3	10^3	2×10^3
3L10	To be used with any 2 or 3-Series Time Base to provide 1-to-36 MHz Spectrum Analysis.			
3S1/3S2/3S5	2 mV/div (max)	Sampling Amplifier (must be paired with Sampling Time Base).		
3T2/3T5/3T77A	0.2 ns/div	Sampling Time Base (must be paired with Sampling Amplifier).		

*Output single ended at rear connector.

**Output at front or rear connector.

In addition to supplying power for the plug-in compartments, the Type 129 provides regulated voltages at a rear-panel connector for powering accessories. Two low-noise fans provide forced-air cooling for the power supply and plug-in compartments.

POWER REQUIREMENTS

Electronically-regulated DC supplies insure stable operation with as much as —10% to +7% variation from design-center line voltage. The instrument is factory wired to operate at a design center of 117 volts, but a multi-tap transformer permits operation at design centers of 110, 117, 124, 220, 234 or 248 volts, 50 to 60 Hz. Instrument can be ordered factory wired for any of the design centers listed. Power consumption is typically 575 watts maximum under full load.

DIMENSIONS AND WEIGHTS

Height	10½ in	26.8 cm
Width	19 in	48.3 cm
Rack depth	23½ in	59.8 cm
Net weight	49½ lb	22.5 kg
Domestic shipping weight	≈ 83 lb	≈37.8 kg
Export-packed weight	≈107 lb	≈48.6 kg

INCLUDED STANDARD ACCESSORIES

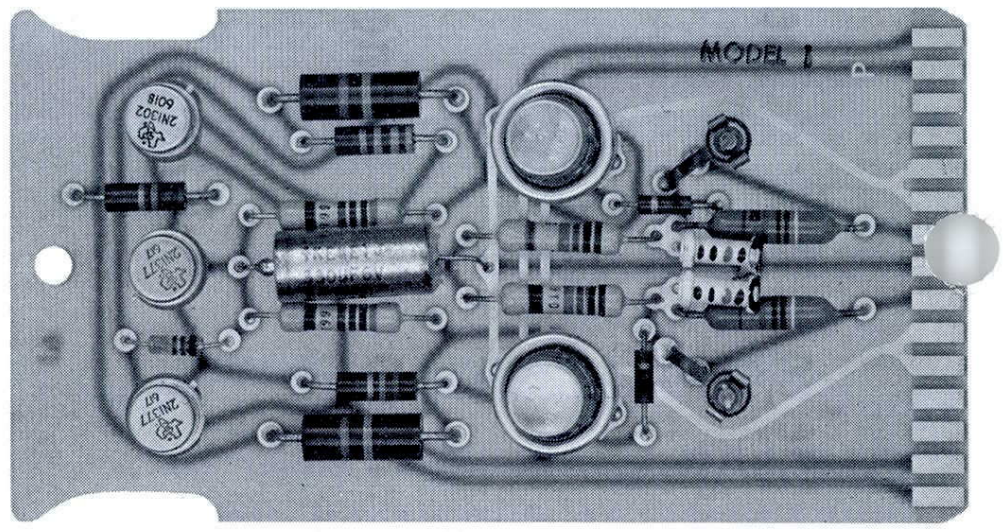
Right-angle power cord (161-0024-03); 3 to 2-wire adapter (103-0013-00); pair of mounting tracks (351-0085-00); two instruction manuals (070-0409-00).

TYPE 129 RACKMOUNT PLUG-IN UNIT POWER SUPPLY
(without plug-in units or circuit cards) **$775**

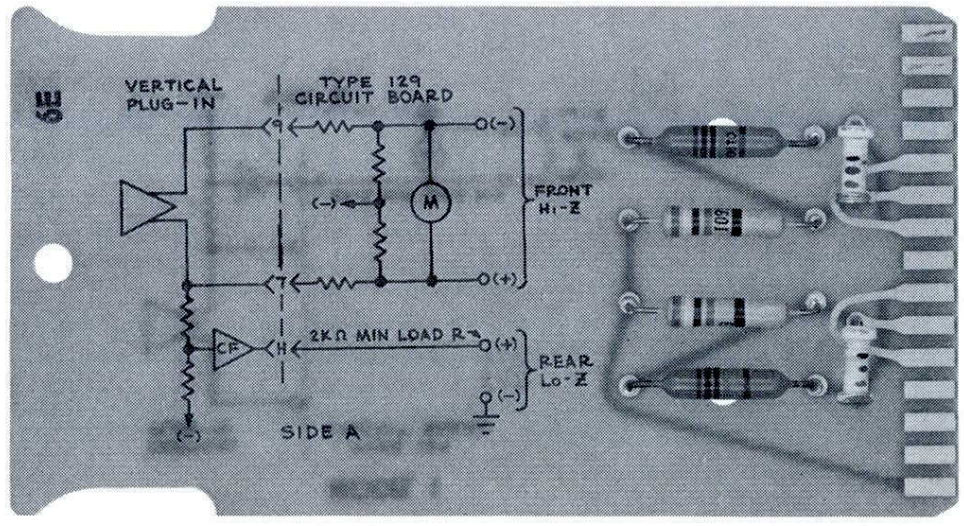
OPTIONAL ACCESSORIES

BLANK PLUG-IN CHASSIS

Contains necessary mechanical parts for construction of a custom plug-in. Includes frame, blank front panel, blank chassis, 24-pin connector, latch and small hardware; electrical components not included. Order 040-0245-00 ..... $27.50



CATHODE-FOLLOWER CIRCUIT CARD **$36.00**
Order 018-0001-00



PASSIVE DIVIDER CIRCUIT CARD **$13.25**
Order 018-0002-00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

3A5 15-MHz Programmable Amplifier 3A5

- ***24-ns RISETIME***
- ***AUTOMATIC SENSITIVITY "SEEKING"***
- ***PROGRAMMABLE FRONT-PANEL FUNCTIONS***
- ***LIGHTED INDICATION OF MEASUREMENT PARAMETERS***

The Type 3A5 is an automatic plug-in unit designed for use in Type 561B and 564B Oscilloscopes. Press the "seek" button on the special 10X probe and the instrument selects the deflection factor for a convenient display size. This "seek" feature is ideal for applications where the instrument is located out of reach, or for production-line testing that requires continuous readjustment of the volts/division control.

Upon receipt of the "seek" command, the deflection factor is automatically selected so that neither peak of the displayed waveform extends more than 3 divisions from the graticule center, thus establishing the display within the CRT viewing area. Large, lighted indicators in the front-panel window tell you at a glance the volts/division setting, input coupling, and when the manual variable volts/division control is in the uncalibrated position.

The Type 3A5 can be operated manually for applications that do not require the automatic features. In addition, the automatic functions are overridden whenever the manual V/div setting is changed. The plug-in can also be operated remotely using the Type 263 External Programmer. Both the "seek" feature and manual operation of the control settings are overridden when the instrument is programmed externally.

Other features of the Type 3A5 include a special "AC Trace Stabilized" circuit that minimizes trace drift. This feature is particularly useful when the instrument is operated at high sensitivity or when long term trace-stability is required.

OPERATING MODES

SEEK, MANUAL AND EXTERNAL

Seek operation selected by front-panel pushbutton or pushbutton on the P6030 Probe. Manual or external operation selected by front-panel pushbuttons.

SEEKING CHARACTERISTICS

DEFLECTION FACTOR

10 mV/div to 50 V/div without probe; 0.1 V/div to 500 V/div with P6030 probe.

SEEKING TIME

≤200 ms. (Time required to complete one "seek" operation).

CYCLING TIME

2 to 4 s (interval between seek operations with "seek" command button held down continuously).

LOGIC CIRCUIT RESPONSE

Seeking circuitry functions for signal rep-rates up to 20 MHz.

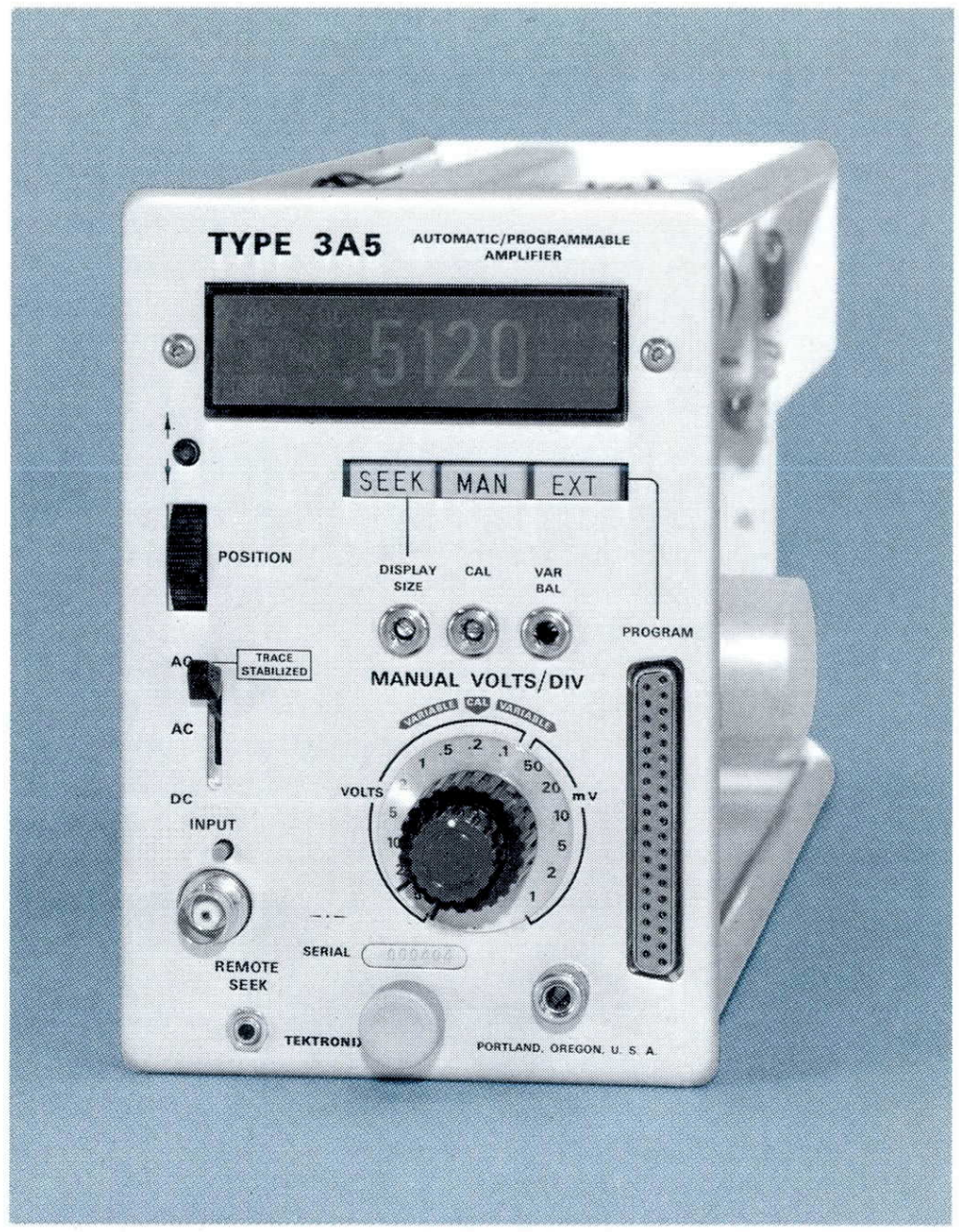
GENERAL CHARACTERISTICS

READOUT FACILITY

Bulb-and-film digits ½ inch high. Readout information includes 1 mV/div to 50 V/div (10 mV/div to 0.5 kV/div when special 10X probe activates the 10X circuit); "AC" or "DC" input coupling, "with probe" indication, and "uncal" indication when using the variable manual V/div control.

DEFLECTION FACTOR

10 mV/div to 50 V/div in 12 calibrated steps, 1-2-5 sequence; accurate within 3%. Additional steps of 1, 2 and 5 mV/div in manual mode only; accurate within 5%. A manual control provides uncalibrated variable V/div settings between all steps.



BANDWIDTH

DC to ≥15 MHz at 3-dB down, from 10 mV/div to 50 V/div (all modes). DC to ≥5 MHz at 1, 2 or 5 mV/div (manual mode only). AC-coupled low-frequency response is 5 Hz, 0.5 Hz with included 10X probe.

RISETIME

≤24 ns at deflection factors of 10 mV to 50 V/div.

INPUT RC

1 megohm paralleled by approx 24 pF.

SIGNAL DELAY

Permits viewing the leading edge of fast-rise waveforms.

PROGRAMMABLE FUNCTIONS

V/div settings, with or without 10X probe, AC or DC input coupling, AC Trace Stabilization, all by contact closure to ground. Vertical positioning by variable resistance.

P6030 PROBE

10X probe with "seek" command button and 6-ft cable. Supplied with the instrument.

WEIGHTS

Net weight	5¼ lb	2.4 kg
Domestic shipping weight	≈11 lb	≈5.0 kg
Export-packed weight	≈14 lb	≈6.4 kg

INCLUDED STANDARD ACCESSORIES

P6030 10X Probe Package (010-0195-00); 37-pin connector (131-0422-00); connector cover (200-0660-02); telephone plug (134-0079-00); two instruction manuals (070-0500-00).

TYPE 3A5 AUTOMATIC/PROGRAMMABLE UNIT . . . $950

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Programmable Time Base

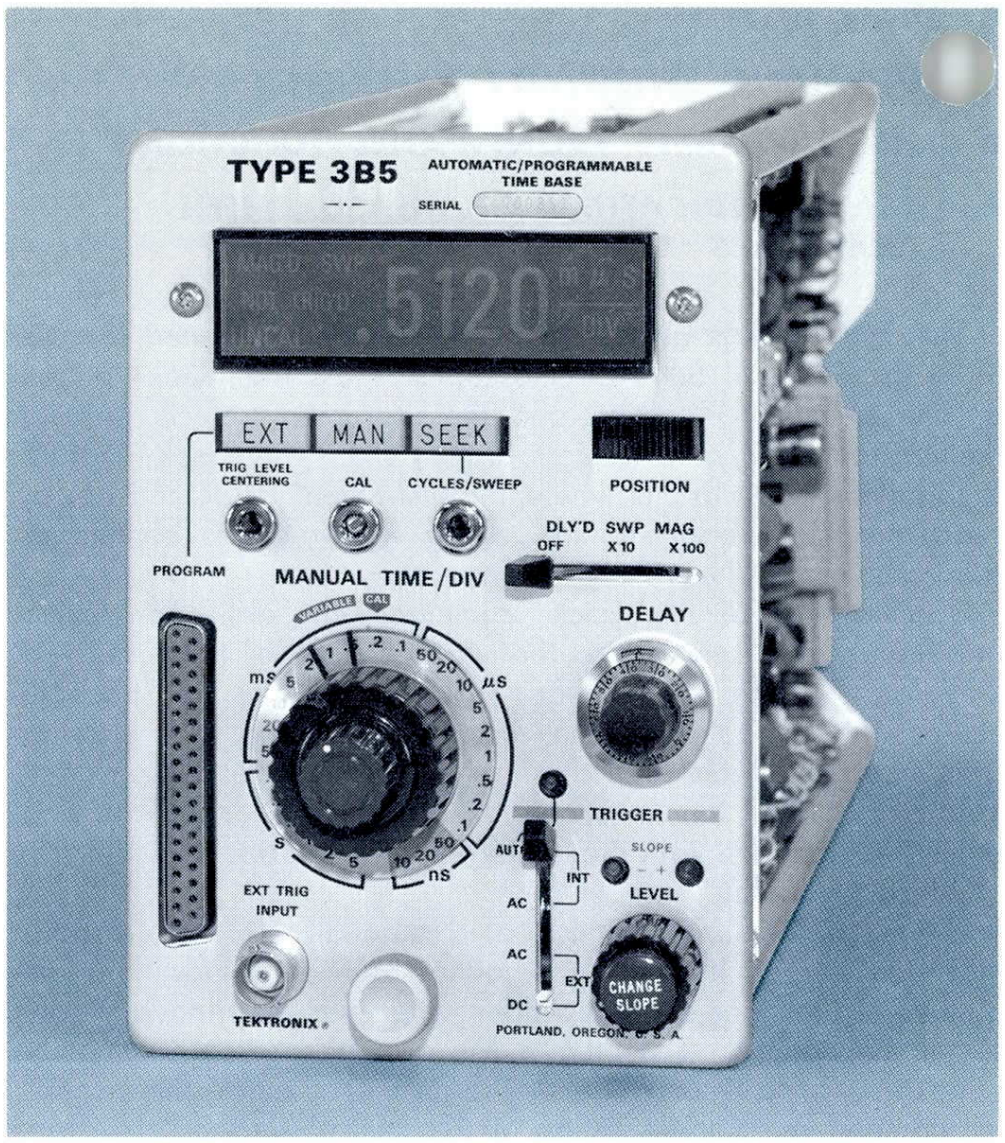
3B5

- ***AUTOMATIC TIME-BASE "SEEKING"***
- ***PROGRAMMABLE FRONT-PANEL FUNCTIONS***
- ***LIGHTED INDICATION OF MEASUREMENT PARAMETERS***
- ***DELAYED SWEEP MAGNIFIER***

Used in association with the Type 3A5 Amplifier and P6030 Probe, the Type 3B5 automatically establishes a triggered time-base display upon receipt of the "seek" command from the probe. The time/division setting is automatically selected to provide a convenient display of 2 to 6 cycles. Lighted indicators in the front-panel window show the selected time/division setting. They also indicate when the time base is not triggered and when the manual variable time/division control is in the uncalibrated position.

The Type 3B5 features a delayed sweep magnifier for expanding the display by X10 or X100. A calibrated delay control selects the point in the display where magnification begins. When the sweep magnifier is in operation, the time/division readout is automatically corrected to indicate the magnified setting, and a "magnified sweep" indication lights up in the readout window.

The automatic "seek" feature of the Type 3B5 is overridden when the manual time/division control is used. Both the "seek" feature and manual operation of the control setting are overridden when the instrument is programmed remotely using the Type 263 External Programmer.



OPERATING MODES

SEEK, MANUAL AND EXTERNAL

Manual or external operation selected by front-panel pushbuttons. Seek operation selected by front-panel pushbutton or pushbutton on the P6030 Probe supplied with the Type 3A5 Amplifier.

SEEKING CHARACTERISTICS

TIME BASE

5 s/div to 0.1 μs/div.

SEEKING TIME

$\leq$500 ms (time required to complete one "seek" operation).

CYCLING TIME

1 to 2 s ("seek" command button held down continuously).

LOGIC CIRCUIT RESPONSE

Seeking circuitry functions for signal rep-rates from 30 Hz to 20 MHz.

GENERAL CHARACTERISTICS

READOUT FACILITY

Bulb-and-film digits ½ inch high. Readout information includes 5 s/div to 10 ns/div sweep times, plus "Magnified Sweep," "Not Triggered," and "Uncalibrated" indications.

TIME BASE

10 ns/div to 5 s/div in 27 calibrated steps, 1-2-5 sequence. Accurate within 3% from 0.1 μs/div to 1 s/div; within 5% at 10, 20, or 50 ns/div and at 2 or 5 s/div. A manual control provides uncalibrated variable time/div settings between all steps and to approx 12.5 s/div.

DELAYED SWEEP MAGNIFIER

Expands the display by a factor of X10 or X100. X10 range magnifies time/division settings from 5 s/div to 1 μs/div. X100 range magnifies time/division settings from 5 s/div to 10 μs/div. Accuracy is within 3% for all magnified sweep times except the 5 and 2 s/div (within 5%). VARIABLE DELAY: 10-turn control determines portion of sweep to be magnified.

TRIGGER MODES

Internal: AC-coupled or Auto. External: AC-coupled or DC-coupled.

TRIGGER REQUIREMENTS

Internal AC, Auto (with Type 3A5): 0.5 div of signal displayed, 50 Hz to 8 MHz, increasing to 2 div at 20 MHz.
External AC: 1 V to 40 V peak to peak, 50 Hz to 20 MHz.
External DC: 2.5 V to 40 V peak to peak, DC to 10 Hz; 1 V to 40 V peak to peak, 10 Hz to 20 MHz.

PROGRAMMABLE FUNCTIONS

Time/div, magnifier range, trigger-mode, slope, and coupling, by contact closure to ground. Horizontal positioning, trigger level, and magnifier delay by variable resistance.

WEIGHTS

Net weight	5 lb	2.3 kg
Domestic shipping weight	≈11 lb	≈5.0 kg
Export-packed weight	≈14 lb	≈6.4 kg

INCLUDED STANDARD ACCESSORIES

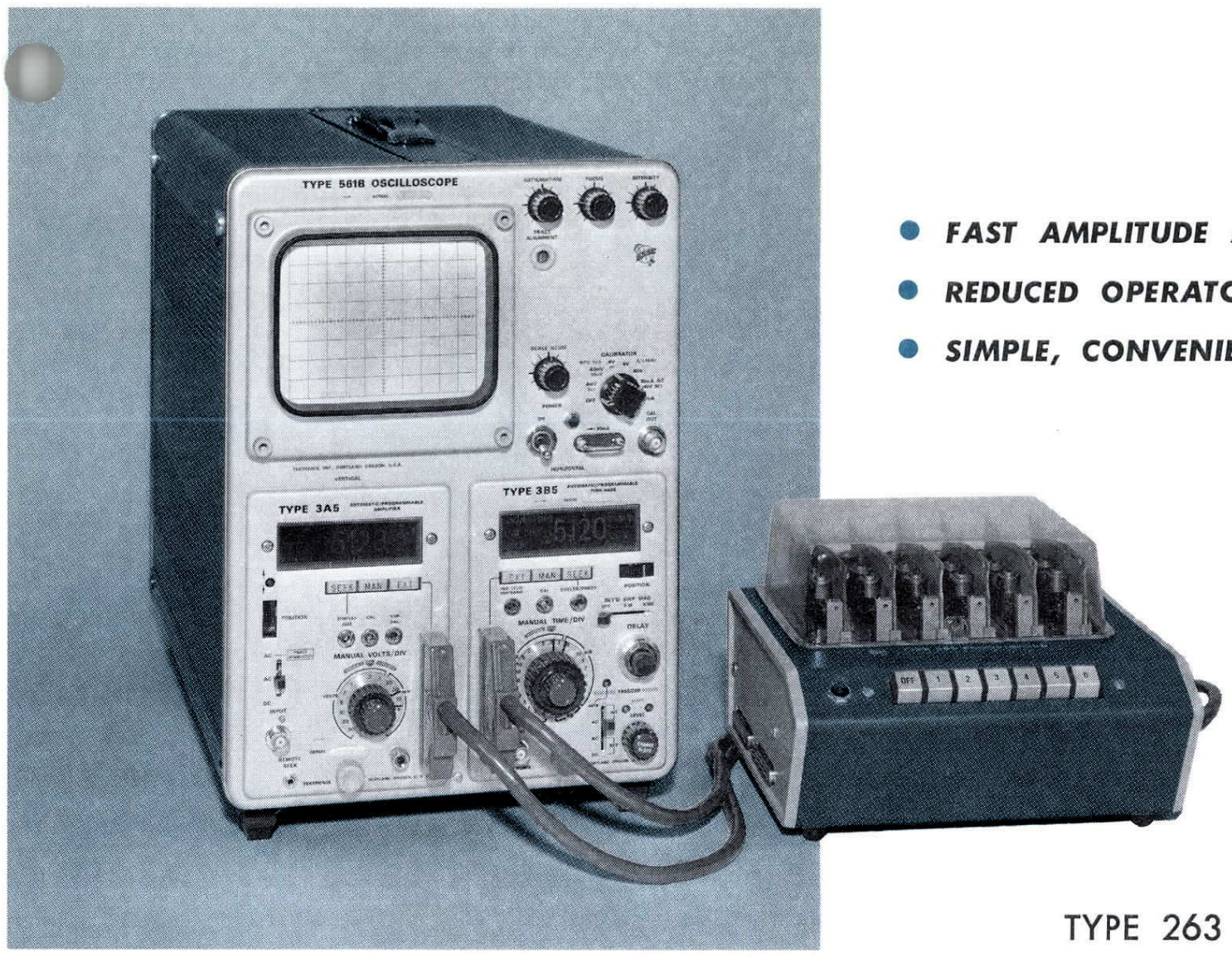
37-pin connector (131-0422-00); connector cover (200-0660-01); two instruction manuals (070-0538-00).

TYPE 3B5 AUTOMATIC/PROGRAMMABLE TIME BASE UNIT $1075

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Programmer

263



- *FAST AMPLITUDE AND TIME MEASUREMENTS*
- *REDUCED OPERATOR ERROR*
- *SIMPLE, CONVENIENT OPERATION*

COMPLETE SYSTEM FOR FAST PRODUCTION-LINE TESTING

The Type 561B Oscilloscope* combined with the Type 3A5, 3B5 Plug-In Units and the Type 263 Programmer, offers the ideal system for making production-line measurements quickly and conveniently . . . and with less chance for operator error. The system allows measurements to be made at the push of a button without changing the manual controls of either plug-in unit. The oscilloscope settings are programmed for a particular measurement and read out in large, lighted indicators on the face of the plug-in units. After the initial program is established, this new system can be operated by personnel with little or no technical training.

The Type 263 Programmer provides the facility for controlling the Type 3A5 and 3B5 Automatic/Programmable Plug-In Units remotely. Pushbuttons on the front panel of the Programmer select any one of six internal program cards. Each card, after initial set-up, establishes the plug-in functions required for a particular test or measurement. More than one programmer can be cascaded for applications requiring more than the six initial measurement set-ups. The plug-in type program cards are identical, allowing them to be interchanged or arranged in any sequence. New programs are easily established by relocating small jumpers and changing the potentiometer settings on the cards.

*Also Type 564B Oscilloscope for storage applications.

TYPE 263 CHARACTERISTICS

PROGRAM CAPABILITIES

All operational controls of the Type 3A5 and Type 3B5 are programmable except the variable volts/division and time/division functions. Program established by jumper placement and potentiometer setting on the program cards.

OUTPUT CABLES

Two 3 ft cables with multi-pin connectors.

CONSTRUCTION

Cast aluminum with wrap-around steel cabinet. Blue vinyl finish.

DIMENSIONS AND WEIGHTS

Height	5¾ in	14.6 cm
Width	8¾ in	22.2 cm
Depth	9 in	22.9 cm
Net weight	5½ lb	2.5 kg
Domestic shipping weight	≈12 lb	≈5.5 kg
Export-packed weight	≈18 lb	≈8.2 kg

INCLUDED STANDARD ACCESSORIES

Eleven electrical leads (175-0674-00); two instruction manuals (070-0535-00).

TYPE 263 PROGRAMMER, with 6 program cards . . **$ 365**
Extra program cards, order 670-0226-00 ea . . . . . **$ 44**

TYPE 561B OSCILLOSCOPE, without plug-in units . . **$ 595**

TYPE 3A5 AMPLIFIER UNIT . . . . . **$ 950**

TYPE 3B5 TIME-BASE UNIT **$1075**

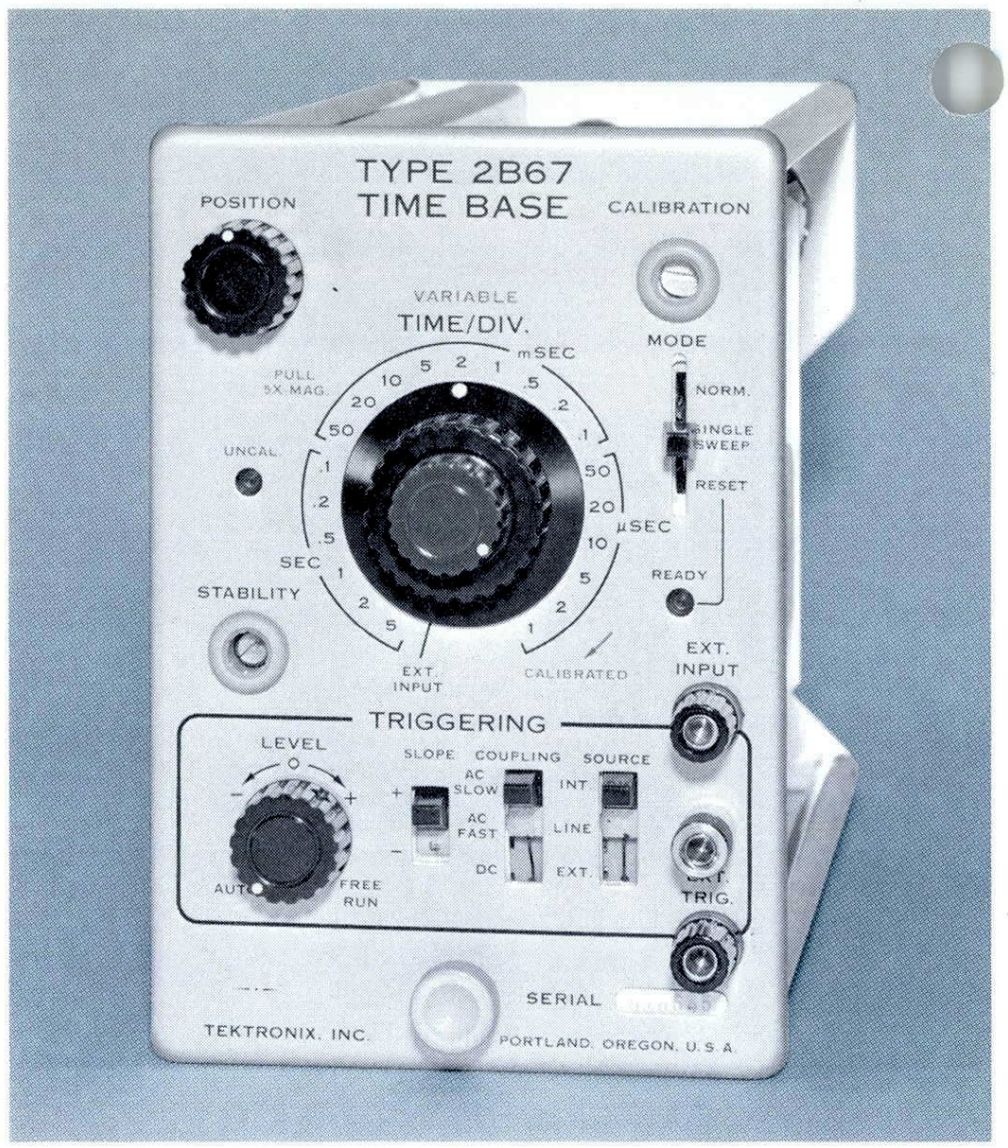
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

SEE THE TYPE 561B, 3A5, 3B5 PAGES FOR INDICATOR AND PLUG-IN UNIT INFORMATION

- *1 μs/DIV-to-5 s/DIV CALIBRATED TIME BASE*
- *5X MAGNIFIER*
- *SINGLE SWEEP OPERATION*
- *LOW COST*

The Type 2B67 Time-Base Unit is designed to generate a sweep in the Type 561B and Type 564B.

The unit is recommended for use with 2- and 3-series vertical plug-in units with bandwidths up to 2 MHz.



TIME BASE

1 μs/div to 5 s/div in 21 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 12 s/div.

5X MAGNIFIER

Operates over full time base, increases the fastest rate to 0.2 μs/div. Magnified display accurate within 5%.

SINGLE SWEEP

For one-shot waveform photography and storage applications.

EXTERNAL HORIZONTAL INPUT

Approx 1 V/div, DC to 750 kHz at —3 dB.

TRIGGER

MODES

Manual, automatic, or free-run.

COUPLING

AC slow, AC fast, or DC.

SOURCES

Internal, external, or line.

REQUIREMENTS

Internal Triggering—0.4 divisions of display, DC to 2 MHz.
External Triggering—0.5 V at DC increasing to 2 V at 2 MHz.

WEIGHTS

Net weight	4¼ lb	1.9 kg
Domestic shipping weight	≈ 7 lb	≈3.2 kg
Export-packed weight	≈11 lb	≈5.0 kg

INCLUDED STANDARD ACCESSORIES

Two instruction manuals (070-0366-00).

TYPE 2B67 TIME-BASE UNIT $235

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information Page.

Delayed-Sweep Time Base

3B3

- ***500 ns/DIV-to-1 s/DIV CALIBRATED TIME BASE***
- ***CALIBRATED DELAYED SWEEP***
- ***TRIGGERING TO 10 MHz***
- ***SINGLE SWEEP OPERATION***

The Type 3B3 Time-Base Unit is used to generate normal and delayed sweeps. Flexible triggering facilities are similar for both the normal sweep and delayed sweep. Calibrated sweep delay enables accurate delay intervals to be set and measured. The unit can be used with the Type 561B or Type 564B, and with the Type 568/230 Oscilloscope, but without digital presentation of the measurement.

DISPLAY MODES

One control can select both the normal and delayed sweeps simultaneously or the delayed sweep rate can be selected independent of the normal sweep.

The normal sweep generator operates as the display time base in (1) the NORMAL position, (2) the INTENSIFIED position—where the delayed-sweep generator intensifies a portion of the normal sweep trace, indicating the time during which the delayed sweep operates—and (3) the TRIGGERED, INTENSIFIED position—where the delayed sweep is armed at the end of the delay time and starts by the delayed sweep trigger . . . intensifying a segment of the normal sweep trace as above.

The delayed-sweep generator operates as the display time base in (1) the DELAYED SWEEP position—displaying the portion of the trace which was intensified in the INTENSIFIED position . . . with time-jitter less than 1 part in 20,000 of the maximum available delay interval—and (2) the jitter-free TRIGGERED, DELAYED SWEEP position—displaying the portion of the trace which was intensified in the TRIGGERED, INTENSIFIED position.

TIME BASE

(Both normal and delayed sweeps.) 0.5 μs/div to 1 s/div in 20 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 2.5 s/div. The Variable control operates with the normal sweep in the normal display mode, and with delayed sweep in all other display modes.

5X MAGNIFIER

Expands the fastest sweep rate to 0.1 μs/div. Magnified sweep accurate within 5%.

SINGLE SWEEP

Facilitates photographic recordings of waveforms.

DELAYED SWEEP MODE

Delayed sweep starts after time interval determined by DELAY TIME and DELAY TIME MULTIPLIER.

DELAY TIME (OR TIME/DIV)

5 μs to 0.2 s, 20 calibrated steps, 1-2-5 sequence; accurate within 1% of indicated delay.

DELAY TIME MULTIPLIER

Continuously calibrated time interval from 0.50 to 10.00 times (dial divided into 1000 parts) the Delay Time; accurate within 0.2% of maximum delay.

DELAY RANGE

2.5 μs to 2 s after delaying sweep start. Inherent delay to start of delayed sweep 500 ns or less.

DIFFERENTIAL TIME

Measurement accuracy within 1% and 1.5 minor divisions.

TRIGGER

MODES

Normal-Sweep Trigger—manual or automatic.
Delayed-Sweep Trigger—manual only.

COUPLING

AC or DC.

SOURCES

Internal or External. Line triggering in normal or delaying sweep operation only.
External trigger facility has two ranges: 0.5 to 15 V and 5 to 150 V, plus or minus polarity.

REQUIREMENTS

Internal Triggering—0.4 major graticule divisions from DC to 5 MHz, increasing to 1 major division at 10 MHz.
External Triggering—0.5 V from DC to 5 MHz, increasing to 1.25 V at 10 MHz. Requirements increase below 6 Hz with AC-coupling.

WEIGHTS

Net weight	5¼ lb	2.3 kg
Domestic shipping weight	≈ 9 lb	≈4.1 kg
Export-packed weight	≈13 lb	≈5.9 kg

INCLUDED STANDARD ACCESSORIES

Two instruction manuals (070-0365-01).

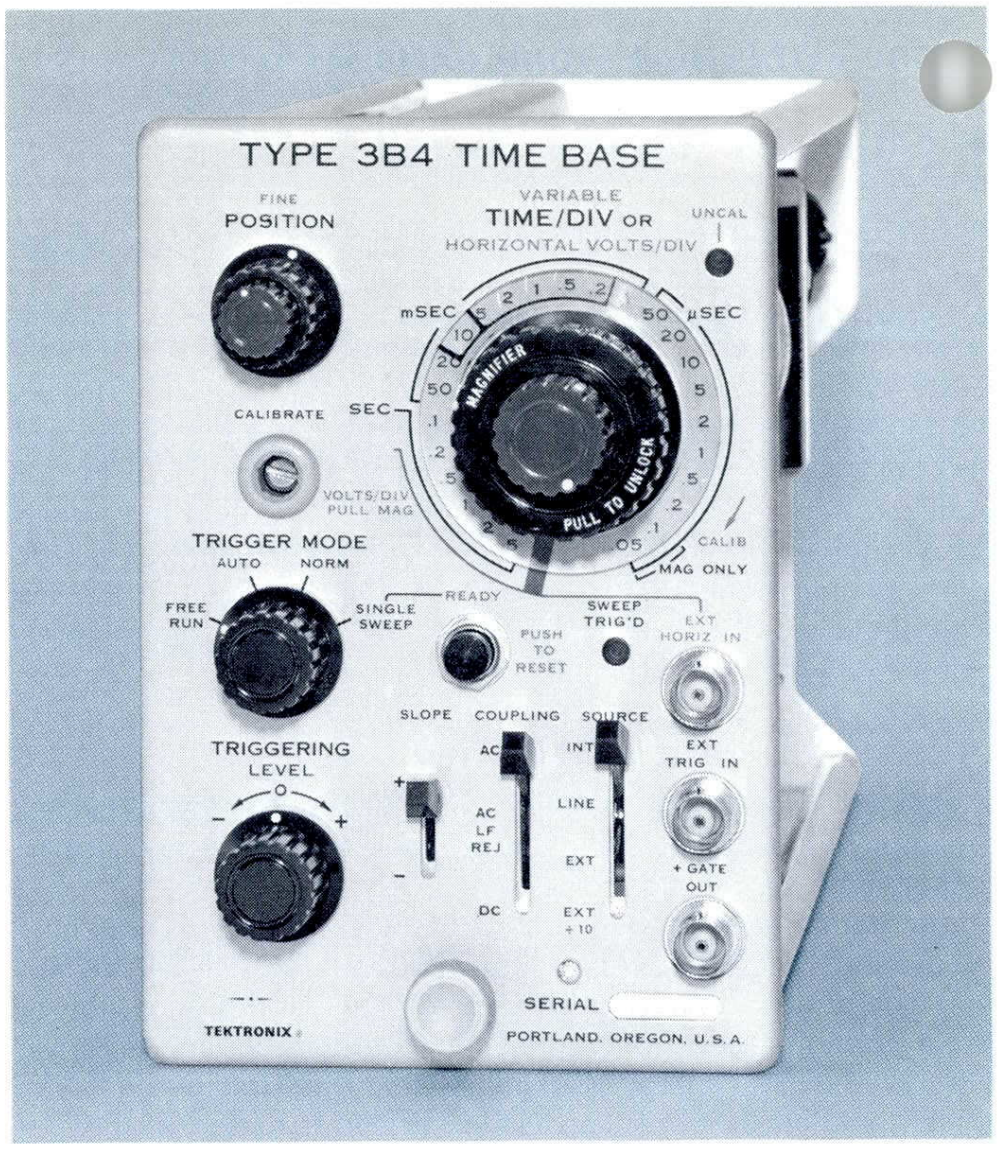
TYPE 3B3 TIME-BASE UNIT $680

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

X50-Mag Time Base

3B4

- ***50 ns/DIV-to-5 s/DIV CALIBRATED TIME BASE***
- ***TRIGGERING TO 20 MHz***
- ***DIRECT READING MAGNIFIER***
- ***CALIBRATED EXTERNAL HORIZONTAL INPUT***
- ***SINGLE SWEEP OPERATION***



The Type 3B4 Plug-In Unit is a wide-range time base with flexible, high-speed triggering facilities, and a wide-range, direct-reading magnifier. It can be used in the Type 561B or Type 564B, and in the Type 568/230 Oscilloscopes, but without digital presentation of the measurement. The Type 3B4 is recommended for operation with Type 3A6 and other wideband ($\geq$2 MHz) vertical amplifier plug-in units.

In addition to time base facilities, the 3B4 provides a DC-coupled external input amplifier with calibrated deflection factors from 0.2 to 5 V/div.

TIME BASE

0.2 μs/div to 5 s/div in 23 calibrated steps, 1-2-5 sequence; accurate within 3% from 0.2 μs/div to 2 s/div, within 5% at 5 s/div. Uncalibrated, continuously variable between steps and to 12.5 s/div.

DIRECT READING MAGNIFIER

Provides sweep expansion up to X50 and extends the fastest sweep rate to 50 ns/div. The MAGNIFIER control is concentric with the TIME/DIV control, providing a direct indication of both the sweep rate being magnified and the magnified time/div rate. Up to 5 magnification steps are provided, to X40, or X50, depending on the TIME/DIV control setting before magnification. Magnified sweep rates are confined to the time/div steps on the panel, so there are no "forbidden" (uncalibrated) combinations. Magnified sweep accurate within 5%.

The MAGNIFIER control is also used to set the external input deflection factor when the TIME/DIV control is in the "Ext Input" position.

EXTERNAL HORIZONTAL INPUT

0.2 V/div to 5 V/div in 5 calibrated steps (max input $\pm$20 V); accuracy, when plug-in unit is matched to oscilloscope, is within 3%. The External Input Amplifier is DC-coupled.

SINGLE SWEEP

Facilitates waveform photography and operation in the Type 561B or 564B Oscilloscope.

TRIGGER

MODES

Manual, free-run, automatic (with bright base-line in absence of a trigger).

COUPLING

AC, AC LF-Reject, DC.

SOURCES

Internal, Line, External, External ÷ 10. A front-panel light indicates when the sweep is receiving a triggering signal—especially convenient when using an external trigger.

REQUIREMENTS

Internal Triggering—1 minor graticule division from DC to 20 MHz, with additional deflection required above 20 MHz. External Triggering—0.5 V to 15 V (EXT) or 5 V to 150 V (EXT ÷ 10) from DC to 20 MHz, with additional signal required above 20 MHz. Requirements increase below 30 Hz with AC-coupling.

WEIGHTS

Net weight	4½ lb	2 kg
Domestic shipping weight	≈ 7 lb	≈3.2 kg
Export-packed weight	≈13 lb	≈5.9 kg

INCLUDED STANDARD ACCESSORIES

Two instruction manuals (070-0431-00).

TYPE 3B4 TIME BASE UNIT $475

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Dual-Trace Sampling Amplifier

3S1

- ***DC-to-1 GHz BANDWIDTH***
- ***INTERNAL TRIGGERING AND DELAY LINES***
- ***2 mV/DIV-to-200 mV/DIV DEFLECTION FACTOR***
- ***DISPLAYED NOISE LESS THAN 2 mV (UNSMOOTHED)***

The Type 3S1 Plug-In Amplifier is a dual-trace sampling unit designed for use in the Type 561B, 564B or Type 568 Oscilloscope. The unit can be used with sampling sweep units, or with real-time time base units allowing sweep rates from 20 ps/div to 5 s/div.

The Type 3S1 features fast-rise, low-noise performance coupled with excellent transient response. The unit has two identical channels, each with internal trigger takeoff and a signal delay line. It can be operated in any of five modes for a variety of single, dual-trace, or X-Y displays. A DC-Offset provision allows the display of signals with DC voltages up to ±1 volt. Power is provided at the front panel for use with probes and other accessories.

CHARACTERISTICS

RISETIME
Less than or equal to 350 ps.

BANDWIDTH
Equivalent to DC to 1 GHz at 3-dB down.

TRANSIENT RESPONSE
±2% or less aberrations in the first 5 ns following the step transition, ±1% or less after 5 ns (as observed with a Tektronix Type 281 TDR Pulser).

DEFLECTION FACTOR
2 mV/div to 200 mV/div in 7 calibrated steps, 1-2-5 sequence. Each step accurate within 3%. Variable between steps, extending to 0.8 mV/div, uncalibrated.

DISPLAYED NOISE
2mV or less unsmoothed, or 1 mV smoothed (includes 90% of dots).

INPUT CHARACTERISTICS
Nominally 50 ohms. Safe overload is ±5 V. GR 874 input connectors.

DC OFFSET RANGE
At least +1 V to −1 V. Allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. Signals between +2 V and −2 V limits may be displayed at 200 mV/div. Monitor jacks provide 10X actual DC offset within 2% through 10 kΩ.

TRIGGERING
Separate internal delay lines and trigger pickoffs permit triggering on either input signal. Trigger pickoffs deliver to the timing unit approximately 10% of the input signal amplitude.

DISPLAY MODES
A only, B only, Dual-Trace, Alegebraic Addition of A and B signals, and X-Y display of A-vertically and B-horizontally (for observation of hysteresis loops, phase shift and similar displays). Independent controls for each channel permit positioning and inverting displays as desired. Time coincidence between channels is within 30 ps.

VERTICAL OUTPUT
200 mV for each division of displayed signal through 10 kΩ. Zero volt level corresponds to center of screen.

PROBE POWER
Available at front-panel connectors for accessories such as Type 281 TDR Pulsers and Type 282 Adapters for high-impedance probes.

WEIGHTS

Net weight	7¾ lb	3.5 kg
Domestic shipping weight	≈11 lb	≈5 kg
Export-packed weight	≈15 lb	≈6.8 kg

INCLUDED STANDARD ACCESSORIES
Two 5-ns 50-Ω RG58/AU cables (017-0512-00); two 10X 50-Ω GR attenuators (017-0078-00); two instruction manuals (070-0632-00).

TYPE 3S1 DUAL-TRACE SAMPLING UNIT $1350

OPTIONAL ACCESSORIES

Type 281 TDR Pulser, order 015-0060-00	$95
Type 282 Probe Adapter, order 015-0074-00	95
P6040/CT-1 Current Probe, order 015-0041-00	40
CT-3 Signal Pickoff, order 017-0061-00	38
VP-1 Voltage pickoff "T", order 017-0073-01	28
P6034 10X Passive Probe, order 010-0110-00	44
P6035 100X Passive Probe, order 010-0111-00	44
Power Divider GR 874-TPD, order 017-0082-00	77
Coupling Capacitor, GR 874-K, order 017-0028-00	12

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Dual-Trace Sampling Amplifier

3S2

- ***PLUG-IN SAMPLING HEADS***
- ***2 mV/DIV-to-200 mV/DIV CALIBRATED DEFLECTION FACTOR***
- ***VARIABLE INTER-CHANNEL DELAY***
- ***NEW PERFORMANCE WITH RANDOM SAMPLING***

The Type 3S2 Dual-Trace Sampling Unit is designed for use in the Type 561B, 564B or 568 Oscilloscope. The unit can be used with sampling sweep units, including the Type 3T2 and 3T5 Sampling Sweeps, or with real-time time base units to allow sweep rates to 5 s/div.

The Type 3S2 accepts two Sampling Heads that can be inserted directly or located remotely with an optional extender. Sampling Heads feature a choice of measurement capabilities and may be mixed or matched to meet specific measurement needs. A front panel control allows adjustment of the inter-channel time relationship to compensate for signal cables or other external delays.

Five display modes provide for a variety of single-trace, dual-trace or X-Y displays. The 3S2 can also be operated with only one head, for applications not presently requiring dual-trace displays.

CHARACTERISTICS

SAMPLING HEADS

May be plugged into the Type 3S2 or located remotely on the optional 3-ft or 6-ft Sampling-Head extenders.

SAMPLING HEAD	RISETIME	INPUT	MINIMUM DEFLECTION FACTOR	DISPLAYED NOISE	PRICE
Type S-1	350 ps	50 Ω, GR874	2 mV/div	2 mV	$300
Type S-2	75 ps	50 Ω, GR874	2 mV/div	6 mV	$355
Type S-3	350 ps	100 kΩ, 2.3 pF	2 mV/div	3 mV	$435
Type S-4	25 ps	50 Ω, 3 mm	2 mV/div	5 mV	$875
Type S-5	1 ns	1 MΩ, 15 pF	2 mV/div	500 μV	$345
Type S-50	25-ps Pulse Generator Head				$525
Type S-51	1-to-18 GHz Trigger Countdown Head				$500

DEFLECTION FACTOR

2 mV/div to 200 mV/div in 7 calibrated steps, 1-2-5 sequence. Each step accurate within 3%. Variable between steps, extending to approximately 0.8 mV/cm, uncalibrated.

DC OFFSET RANGE

+1 V to −1 V. Allows signals between +1-V and −1-V limits to be displayed at 2 mV/div. Signals between +2-V and −2-V limits can be displayed at 200 mV/div. Monitor jacks provide 10X actual DC offset within 2% through 10 kΩ.

TRIGGERING

Trigger pickoff within most Sampling Heads permits triggering on either input signal. 50-Ω Trigger Out connector at the front panel delivers pulse signals with approximately 1X gain for AC signals up to 500 mV peak-to-peak and 2-ns risetime to the 50-Ω External Trigger Input of the sweep unit.

B-DELAY RANGE

Channel B display can be continuously positioned in time from +5 ns to −5 ns with respect to Channel A. Accommodates 3-foot difference in signal or Sampling-Head cables.

DISPLAY MODES

A only, B only, Dual Trace, Algebraic Addition of A and B signals, and X-Y display of A-vertically and B-horizontally, (for observation of hysteresis loops, phase shift, and similar displays). Independent controls for each channel permit positioning and inverting displays as desired.

VERTICAL OUTPUT

200 mV for each division of displayed signal through 10 kΩ.

WEIGHTS

Net weight	5½ lb	2.5 kg
Domestic shipping weight	≈ 9 lb	≈4.1 kg
Export-packed weight	≈12 lb	≈5.5 kg

INCLUDED STANDARD ACCESSORIES

10-inch RG58 trigger cable with BNC/BSM connectors (012-0128-00); 18-inch RG58 trigger cable with BNC/BSM connectors (012-0127-00); two instruction manuals (070-0759-00).

TYPE 3S2 DUAL-TRACE SAMPLING UNIT, without sampling heads **$950**

OPTIONAL ACCESSORIES

3-ft Sampling-Head extender, order 012-0124-00 . . . . . $64

6-ft Sampling-Head extender, order 012-0125-00 . . . . . $66

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Programmable Sampling Amplifier

3S5

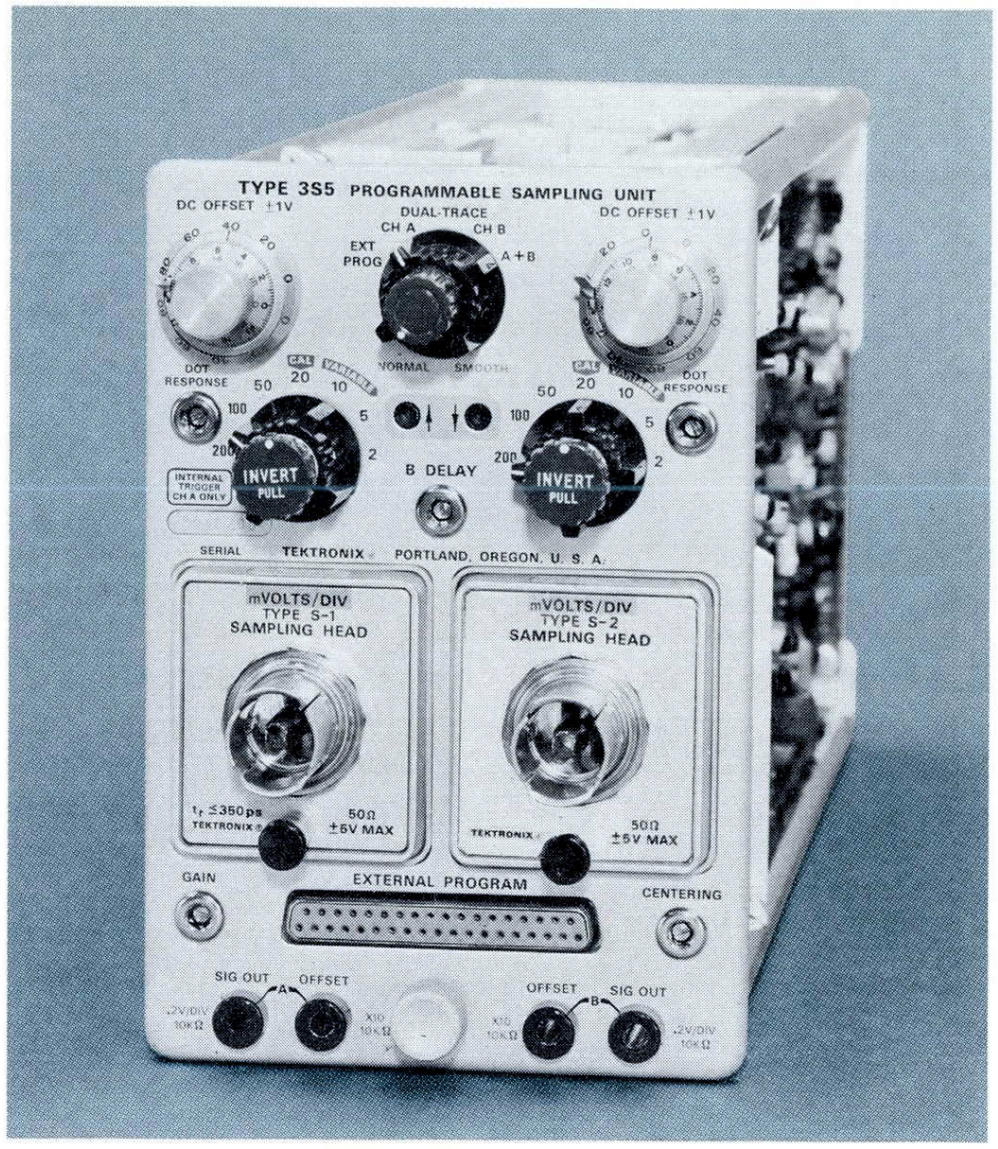
- ***PROGRAMMABLE VOLTS/DIV***
- ***PROGRAMMABLE DC OFFSET***
- ***PLUG-IN SAMPLING HEADS***
- ***FRONT AND REAR PANEL PROGRAM CONNECTORS***

The Type 3S5 can be used in the Type 561B and 564B Oscilloscopes, where it may be operated manually from the front panel or externally programmed.

The Type 3S5 Programmable Sampling Unit also extends the automated measurement capabilities of the Type 568 Digital Readout Oscilloscope by allowing remote programming of the vertical plug-in measurement functions.

The Type 3S5 is a dual-trace programmable vertical unit featuring Sampling Heads that plug-in directly or are located remotely with the optional Sampling-Head extenders. Most of the measurement functions of the Type 3S5 are externally programmable through use of parallel multi-pin connectors on the front panel of the plug-in and the rear panel of the Type 568 Oscilloscope. Programmable functions include deflection factor, DC offset and smoothing.

Sampling Heads feature a choice of measurement capabilities and may be mixed or matched to meet specific measurement needs. A front-panel control allows adjustment of the interchannel time relationship to compensate for signal cables or other external delays.



CHARACTERISTICS

SAMPLING HEADS

May be plugged into the Type 3S5 or located remotely on the optional 3-ft or 6-ft Sampling-Head extenders.

SAMPLING HEAD	RISETIME	INPUT	MINIMUM DEFLECTION FACTOR	DISPLAYED NOISE	PRICE
Type S-1	350 ps	50 Ω, GR874	2 mV/div	2 mV	$300
Type S-2	75 ps	50 Ω, GR874	2 mV/div	6 mV	$355
Type S-3	350 ps	100 kΩ, 2.3 pF	2 mV/div	3 mV	$435
Type S-4	25 ps	50 Ω, 3 mm	2 mV/div	5 mV	$875
Type S-5	1 ns	1 MΩ, 15 pF	2 mV/div	500 μV	$345

DEFLECTION FACTOR

2 mV/div to 200 mV/div in 7 calibrated steps, 1-2-5 sequence. Each step accurate within 3% in normal mode, within 4% smoothed. Vertical outputs to the Type 230, each channel programmed with 3 program lines or by manual front-panel controls.

DC OFFSET RANGE

+1 V to −1 V. Allows signals between +1-V and −1-V limits to be displayed at 2 mV/div. Continuously variable and calibrated with front-panel controls between +1 V and −1 V, accurate within 10 mV of same offset voltage obtained in the external program mode. Programmable between +995 mV and −995 mV in 5-mV steps. The programmable accuracy is within 2% or 5 mV (whichever is greater) of the programmed value. Programming is accomplished with 9 program lines per channel in modified BCD code plus one program line per channel for + or − polarity.

B-DELAY RANGE

Channel B display can be continuously positioned in time from +5 ns to −5 ns with respect to Channel A. Accommodates up to 3-foot difference in signal cable or Sampling-Head extenders.

PROGRAMMING

The Type 3S5 uses negative logic with true being ground or <2 V, and false being open or >6 V. The units/div range is programmed with 3 lines per channel. DC offset is programmed with 9 lines per channel in modified BCD code plus one line per channel for + or − polarity. One line is used to program smoothed or normal operation. A total of 27 program lines plus ground is required to externally program all the measurement functions of the Type 3S5.

DISPLAY MODES

A only, B only, dual trace, algebraic addition of A and B signals. In the external program mode, dual-trace operation is automatically provided. Independent controls for each channel permit positioning and inverting displays as desired.

WEIGHTS

Net weight	6¼ lb	2.8 kg
Domestic shipping weight	≈10 lb	≈4.5 kg
Export-packed weight	≈14 lb	≈6.3 kg

INCLUDED STANDARD ACCESSORIES

Connector (131-0422-00); connector cover (200-0660-00); circuit board connector (388-0805-00); two instruction manuals (070-0788-00).

TYPE 3S5 PROGRAMMABLE SAMPLING UNIT, without Sampling Heads **$1700**

OPTIONAL ACCESSORIES

3-ft Sampling-Head extender, order 012-0124-00 ..... $64

6-ft Sampling-Head extender, order 012-0125-00 ..... $66

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

S-1 Sampling Heads S-2

- ***DC-TO-1 GHz BANDWIDTH***
- ***DISPLAYED NOISE LESS THAN 2 mV (unsmoothed)***

The Type S-1 Sampling Head is a low-noise, 350-ps risetime unit with a 50-Ω input impedance. It is designed for use with the Type 3S2, 3S5 and 3S6 Dual-Trace Sampling Units, and can be plugged in or attached by a cable for remote use. A trigger pickoff within the Type S-1 provides a trigger signal output from the plug-in unit. When used with the Type 3T2 Random Sampling Sweep Unit, the triggering event may be displayed on the screen without the use of delay lines or a pretrigger.

RISETIME
Less than or equal to 350 ps.

BANDWIDTH
Equivalent to DC to 1 GHz at 3-dB down.

TRANSIENT RESPONSE
Aberrations as observed with the Type 284 Pulse Generator are +0.5%, —3% or less, total of 3.5% or less P-P, first 5 ns following the step transition; +0.5%, —0.5% or less, total of 1% or less P-P after 5 ns.

DISPLAYED NOISE
2 mV or less, unsmoothed; 1 mV, smoothed (includes 90% of dots).

SIGNAL RANGE
Variable DC offset allows signals between +1 V and —1 V limits to be displayed at 2 mV/div. Signals between +2 V and —2 V limits may be displayed at 200 mV/div. For best dot-transient response with random-sampling sweep unit, signal amplitude should be less than 500 mV P-P.

INPUT CHARACTERISTICS
Nominally 50 Ω. Safe overload is ±5 V. GR 874 input connectors.

WEIGHTS

Net weight	¾ lb	0.34 kg
Domestic shipping weight	≈2 lb	≈0.9 kg

INCLUDED STANDARD ACCESSORIES
5-ns, 50-Ω RG58/AU cable (017-0512-00); 10X, 50-Ω, GR attenuator (017-0078-00); instruction manual (070-0763-00).

TYPE S-1 SAMPLING HEAD $300

- ***DC-TO-4.5 GHz BANDWIDTH***
- ***DISPLAYED NOISE LESS THAN 6 mV (unsmoothed)***

The Type S-2 Sampling Head is a 75-ps risetime unit with a 50-Ω input impedance. It is designed for use with the Type 3S2, 3S5 and 3S6 Dual-Trace Sampling Units, and can be plugged in or attached by a cable for remote use. A trigger pickoff within the Type S-2 provides a trigger signal output from the plug-in unit. When used with the Type 3T2 Random Sampling Sweep Unit, the triggering event may be displayed on the screen without the use of delay lines or a pretrigger.

RISETIME
Less than or equal to 75 ps.

BANDWIDTH
Equivalent to DC to 4.5 GHz at 3-dB down.

TRANSIENT RESPONSE
Aberrations as observed with the Type 284 Pulse Generator are +5%, —5% or less, total of 10% or less P-P, first 2.5 ns following a step transition; +2%, —2% or less, total of 4% or less P-P after 2.5 ns.

DISPLAYED NOISE
6 mV or less, unsmoothed; 3 mV, smoothed (includes 90% of dots).

SIGNAL RANGE
Variable DC offset allows signals between +1 V and —1 V limits to be displayed at 2 mV/div. Signals between +2 V and —2 V limits may be displayed at 200 mV/div. For best dot-transient response with random-sampling sweep unit, signal amplitude should be less than 200 mV P-P.

INPUT CHARACTERISTICS
Nominally 50 Ω. Safe overload is ±5 V. GR 874 input connectors.

WEIGHTS

Net weight	¾ lb	0.34 kg
Domestic shipping weight	≈2 lb	≈0.9 kg

INCLUDED STANDARD ACCESSORIES
5-ns, 50-Ω RG213 cable (017-0502-00); 10X, 50-Ω, GR attenuator (017-0078-00); instruction manual (070-0764-00).

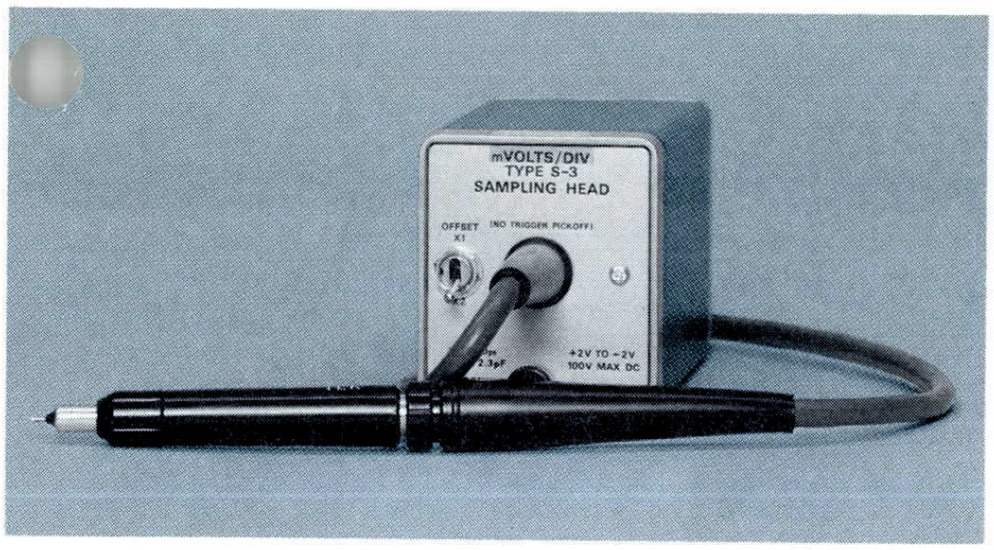
TYPE S-2 SAMPLING HEAD $355

OPTIONAL ACCESSORIES

P6040/CT-1 Current Probe, order 015-0041-00 ..... $40
CT-2 Signal Pickoff, order 017-0061-00 38
VP-1 Voltage Pickoff "T", order 017-0073-01 28
P6034 10X Passive Probe, order 010-0110-00 44
P6035 100X Passive Probe, order 010-0111-00 ..... $44
Power Divider GR 874-TPD, order 017-0082-00 77
Coupling Capacitor, GR 874-K order 017-0028-00 12

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

S-3 Sampling Heads S-4



- ***COMPACT, 3.5-FT, 100-kΩ, 2.3-pF PROBE***
- ***DC-to-1 GHz BANDWIDTH***
- ***DISPLAYED NOISE LESS THAN 3 mV (unsmoothed)***

The Type S-3 Sampling Head is a low-noise, 350-ps risetime, sampling-probe unit with a 100-kΩ, 2.3-pF input impedance. A switch selects a DC offset of X1 or X2 while maintaining a 2-mV/div deflection factor. The Type S-3 can be plugged in or attached by an optional extender for remote use with the Type 3S2, 3S5, and 3S6 Dual-Trace Sampling Units. When used with the Type 3T2 Random Sampling Sweep Unit, the triggering event may be displayed on the screen without the use of delay lines or a pretrigger.

RISETIME
Probe only, 350 ps or less.

BANDWIDTH
Probe only is equivalent to DC-to-1 GHz at 3-dB down.

TRANSIENT RESPONSE (Probe Only)
Aberrations in the first 2 ns following a step are +8%, −2% or less, total of 10% or less P-P, +1%, −1% or less, total of 2% or less P-P after 2 ns, as observed with Type 284.

DISPLAYED NOISE (Probe Only)
≤3 mV referred to probe tip (includes 90% of dots).

SIGNAL RANGE
Variable DC offset allows signals between +1 V and −1 V, X1 range; or +2 V and −2 V, X2 range to be displayed at 2 mV/div. The signal range may be increased X10 or X100 with the use of the probe attenuators.

PROBE ACCURACY
Accuracy is within 1% for probe only.

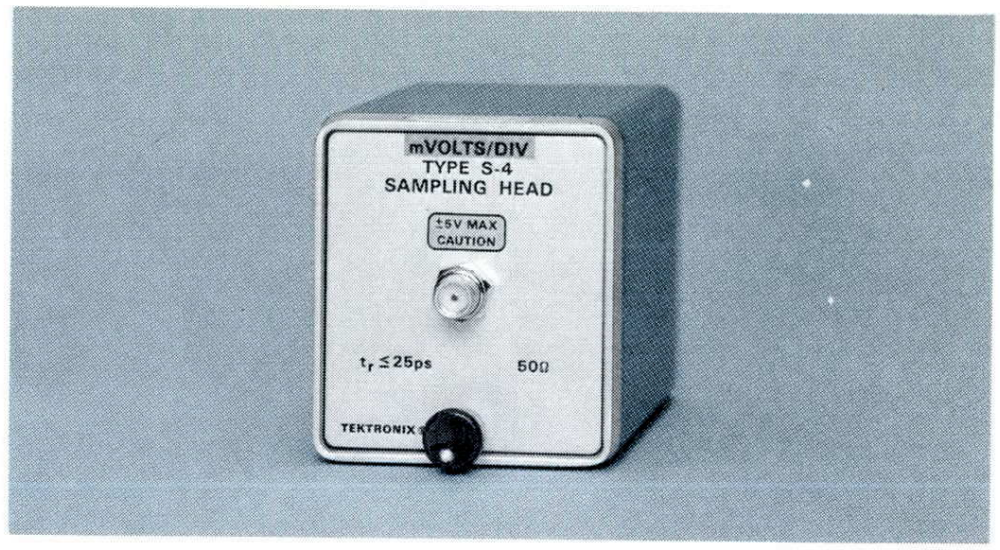
INPUT CHARACTERISTICS
Probe only is 100 kΩ paralleled by 2.3 pF.

WEIGHTS

Net weight	3 lb	1.4 kg
Domestic shipping weight	≈ 5 lb	≈2.3 kg
Export-packed weight	≈10 lb	≈4.5 kg

INCLUDED STANDARD ACCESSORIES
10X attenuator (010-0364-00), 100X attenuator (010-0365-00), coupling capacitor (011-0098-00), probe tip (206-0114-00), bayonet-ground adapter (013-0085-00), two test-point jacks (131-0258-00), 5½-inch ground lead (175-1017-00); 12½-inch ground lead (175-1018-00); 3-inch cable assembly (175-0249-00); three probe clips (344-0046-00); end cap (200-0834-00); two end caps (200-0835-00); probe holder (352-0090-00); retractable hook tip (013-0097-00); 50-Ω voltage pickoff (017-0077-01), carrying case (016-0121-00), manual (070-0765-00).

TYPE S-3 SAMPLING HEAD $435



- ***25-ps SAMPLING HEAD***
- ***DC-to-14 GHz BANDWIDTH***
- ***DISPLAYED NOISE LESS THAN 5 mV (unsmoothed)***

The Type S-4 Sampling Head is a 25-ps risetime unit with a 50-Ω input impedance. It is designed for use with the Type 3S2, 3S5 and 3S6 Dual-Trace Sampling Units. The Type S-4 can be plugged into the sampling unit or attached by a Sampling-Head extender for remote use. A trigger pickoff within the Type S-4 provides a trigger signal output from the plug-in unit. When used with the Type 3T2 Random Sampling Sweep Unit, the triggering event may be displayed on screen without the use of delay lines or a pretrigger.

RISETIME
Less than or equal to 25 ps.

BANDWIDTH
Equivalent to DC-to-14 GHz at 3-dB down.

TRANSIENT RESPONSE
Aberrations in the first 400 ps following a step are: −10%, +10% or less, total of 20% or less P-P as observed with Type S-50; from 400 ps to 25 ns following a step, 0%, +10% or less, total of 10% or less P-P, as observed with Type 284; after 25 ns, −2%, +2% or less, total of 4% or less P-P as observed with Type 284.

DISPLAYED NOISE
5 mV or less, unsmoothed; 2.5 mV, smoothed (includes 90% of dots).

SIGNAL RANGE
Variable DC offset allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. For best dot-transient response with random-sampling sweep unit, signal amplitude should be less than 500 mV P-P.

INPUT CHARACTERISTICS
Nominally 50 Ω. Safe overload ±5 V. 3-mm input connector.

WEIGHTS

Net weight	¾ lb	0.34 kg
Domestic shipping weight	≈3 lb	≈0.9 kg

INCLUDED STANDARD ACCESSORIES
2-ns cable with 3-mm connectors (015-1005-00); 10X 50-Ω 3-mm attenuator (015-1003-00); GR874 to 3-mm male adapter (015-1007-00); 3-mm male-to-male adapter (015-1011-00); 5/16-inch wrench (003-0247-00); instruction manual (070-0896-00).

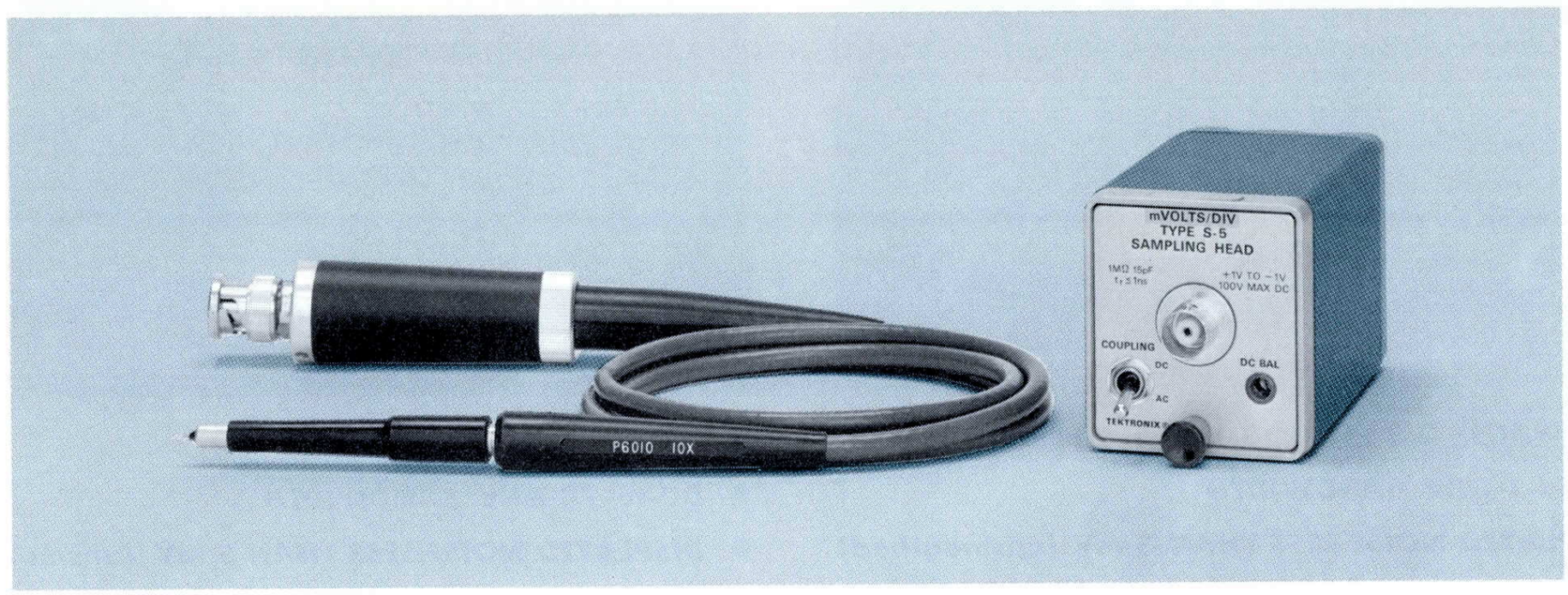
TYPE S-4 SAMPLING HEAD $875

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

NEW

S-5 Sampling Head

S-5



- ***1-MΩ, 15-pF INPUT IMPEDANCE***
- ***PASSIVE PROBE***
- ***DISPLAYED NOISE LESS THAN 500 μV***
- ***INTERNAL TRIGGER PICKOFF***

The Type S-5 Sampling Head is a low noise, 1-ns risetime sampling unit with a 1-MΩ, 15-pF input impedance. When used with the P6010 passive probe the input impedance increases to 10 MΩ, 10 pF while maintaining the 1-ns t_r at the probe tip. A switch on the sampling head selects either AC or DC coupling of the input.

The Type S-5 Sampling Head is designed for use with the Types 3S2, 3S5 and 3S6 Dual-Trace Sampling Units and can be plugged in or attached by an optional Sampling-Head extender for remote use. When used with the Type 3T2 Random Sampling Sweep Unit, the triggering event may be displayed on the screen without the use of delay lines or a pretrigger.

CHARACTERISTICS

RISETIME
S-5 only, 1 ns or less; with 3.5 foot P6010, 1 ns or less.

BANDWIDTH
Equivalent to DC-to-350 MHz at 3-dB down at input connector or probe tip.

TRANSIENT RESPONSE
(Driven with a 50-Ω source)
S-5 only (terminated in 50 Ω): aberrations +2.5%, —5% or less, total of 7.5% or less P-P within 17 ns after step +1%, —1% or less, total of 2% or less P-P thereafter.

S-5/P6010 (3.5-foot probe properly compensated): aberrations +5%, —5% or less, total of 10% or less P-P within 17 ns after step; +1%, —3% or less, total of 4% or less P-P thereafter.

DISPLAYED NOISE
S-5 only, 500 μV or less (includes 90% of dots).
S-5/P6010, 5 mV or less (includes 90% of dots).

SIGNAL RANGE
S-5 only: DC coupled (DC + peak AC)—1 V P-P; AC coupled, DC voltage—100 V.
S-5/P6010: DC coupled (DC + peak AC)—10 V P-P; AC coupled, DC voltage—100 V.

INPUT CHARACTERISTICS
S-5 only is 1 MΩ within 1% paralleled by 15 pF within 1 pF.
S-5/P6010 is 10 MΩ paralleled by approx 10 pF.

ATTENUATION ACCURACY
Probe attenuation is 10X within 3%.

WEIGHT

Net Weight	≈ 9 oz	≈ .24 kg

INCLUDED STANDARD ACCESSORIES
P6010 probe package (010-0188-00), 50-Ω termination (011-0049-01), manual (070-0942-00).

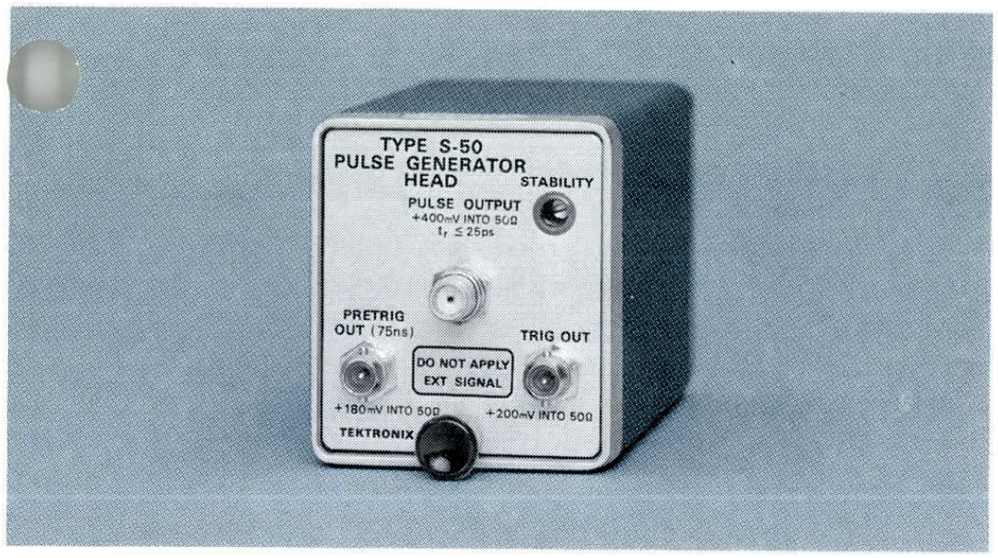
TYPE S-5 SAMPLING HEAD **$345**

OPTIONAL ACCESSORIES

Probe tip-to-BNC adapter, order 013-0084-01 ..... $5.30
Probe tip-to-GR adapter, order 017-0076-00 ..... $8.30

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

S-50 Pulse Generator



- ***25-ps PULSE RISETIME***
- ***400-mV PULSE AMPLITUDE***
- ***100-ns PULSE WIDTH***

The Type S-50 Pulse Generator Head is a high-speed, tunnel-diode step generator designed for use in the Type 3S2, 3S5 and 3S6 Sampling Unit or in the Type 285 Power Supply Unit. The Type S-50 when used with the Type S-4 Sampling Head provides high-resolution 35-ps TDR measurements. The Type S-50 is also used for verification of sampling system risetimes. A pretrigger output allows operation with sequential sampling systems.

CHARACTERISTICS

PULSE OUTPUT

Risetime is 25 ps or less. Amplitude into 50 Ω is at least 400 mV, positive going. Pulse duration is 100 ns, pulse repetition rate is 25 kHz. Pulse aberrations following the step are: −10%, +10% with a total of 20% or less P-P in the first 400 ps; −5%, +5% with a total of 8% or less P-P from 400 ps to 5 ns; −4%, +1% with a total of 5% or less P-P after 5 ns.

PRETRIGGER OUTPUT

Risetime is 400 ps or less. Amplitude into 50 Ω is at least 180 mV, positive going. Pretrigger pulse duration is 4 ns. Pretrigger occurs 75 ns (±5 ns) before the pulse output. Pretrigger to pulse output jitter is 15 ps or less.

TRIGGER OUTPUT

Risetime is 200 ps or less. Amplitude into 50 Ω is at least 200 mV, positive going. Trigger pulse duration is 100 ns. The trigger output occurs in time coincidence with the pulse output.

POWER REQUIREMENTS

The necessary power is provided from the Type 3S2, 3S5, 3S6 or Type 285 Power Supply.

OUTPUT CONNECTORS

Pulse output uses a 3-mm connector. Pretrigger output and trigger output use BSM connectors. A pretrigger output from the rear of the Type S-50 provides a pretrigger pulse for internal triggering of the sampling sweep unit.

WEIGHTS

Net weight	¾ lb	0.34 kg
Domestic shipping weight	≈3 lb	≈0.9 kg

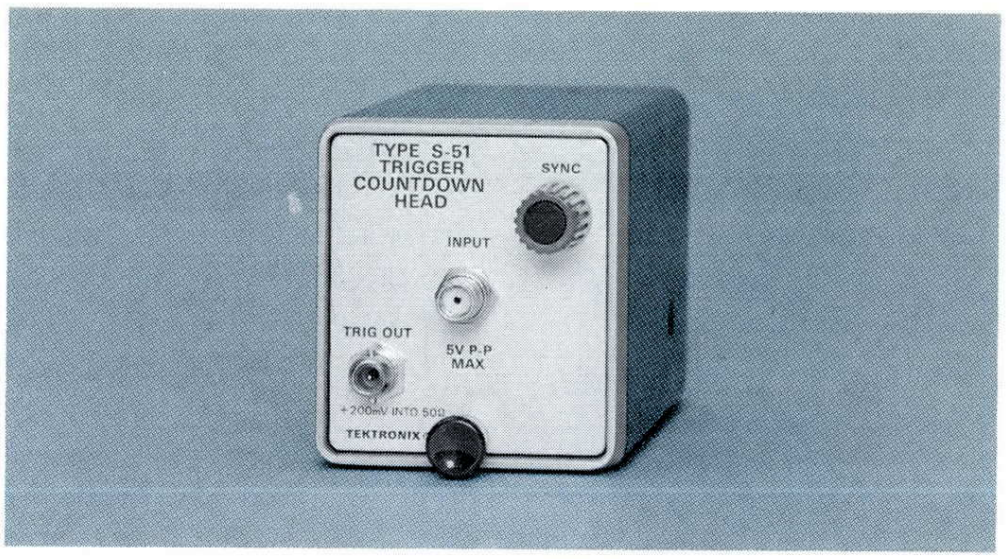
INCLUDED STANDARD ACCESSORIES

500 ps 50 Ω semi-rigid coax (015-1015-00); instruction manual (070-0897-00).

TYPE S-50 PULSE GENERATOR HEAD $525

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Trigger Countdown Head S-51



The Type S-51 Trigger Countdown Head is a free-running tunnel-diode oscillator designed to provide stable sampling displays of signals up to 18 GHz. The Type S-51 may be used with the Type 3S2, 3S5 and 3S6 Sampling Units in place of one of the Sampling Heads, or it may be operated separately with the Type 285 Power Supply. The Type S-51 has a front-panel sync control that synchronizes the oscillator frequency to a sub-harmonic of the input signal. The output from the Type S-51 is available at a front-panel trigger output connector and through a rear-panel connector for internal triggering. The output signal is a direct countdown of the input and permits triggering by a standard sampling time-base unit.

CHARACTERISTICS

INPUT SIGNAL

Frequency range is 1 GHz to 18 GHz. Stable synchronization on signals at least 100 mV P-P, as measured separately into 50 Ω; 5 V, P-P maximum.

INPUT CHARACTERISTICS

50-Ω 3-mm connector. Open termination paralleled by 1 pF.

TRIGGER OUTPUT

Front panel trigger output is at least 200 mV into 50 Ω, Type BSM connector. Internal trigger output is at least 100 mV into 50 Ω, internally connected to sampling unit. Jitter is 10 ps or less, with signals from 5 GHz to 18 GHz; 15 ps or less with signals from 1 GHz to 5 GHz. Kickout at signal input connector is 400 mV or less, kickout occurs between successive samples.

POWER REQUIREMENTS

The necessary power is provided from the Type 3S2, 3S5, 3S6 or Type 285 Power Supply.

WEIGHT

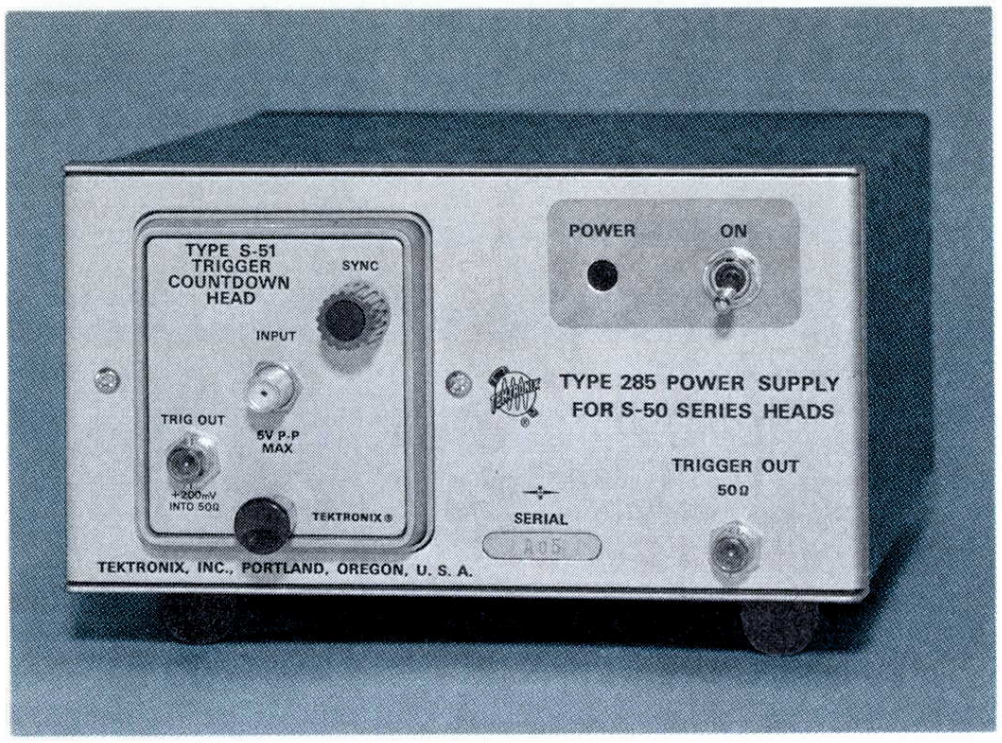
Net weight	¾ lb	0.34 kg
Domestic shipping weight	≈2 lb	≈0.9 kg

INCLUDED STANDARD ACCESSORIES

Instruction manual (070-0898-00).

TYPE S-51 TRIGGER COUNTDOWN HEAD $500

285 Power Supply



- ***ACCEPTS ONE TYPE S-50 SERIES HEAD***
  TYPE S-50 PULSE GENERATOR HEAD
  TYPE S-51 TRIGGER COUNTDOWN HEAD

The Type 285 Power Supply is designed for use with either the Type S-50 Pulse Generator Head or the Type S-51 Trigger Countdown Head. The Type 285 provides the regulated power supplies necessary to power one Type S-50 Series Head. It also provides a front panel trigger output jack. The trigger output jack provides the internal trigger pulse from the plug-in Head to the front panel of the Type 285.

CHARACTERISTICS

POWER REQUIREMENTS

90 V to 136 V or 180 V to 272 V, 50 Hz to 400 Hz, 8.5 watts at 115 V and 60 Hz. Slide switch on rear panel selects high or low voltage operation.

TRIGGER OUTPUT

BSM Connector provides internal trigger output of Type S-50 Series Heads to the front panel.

DIMENSIONS AND WEIGHTS

Height	3⅛ in	5.1 cm
Width	5 in	12.7 cm
Depth	8 in	20.3 cm
Net weight	3⅛ lb	1.4 kg
Domestic shipping weight	4 lb	2.8 kg

INCLUDED STANDARD ACCESSORIES

3-to-2 wire adapter (103-0013-00); two instruction manuals (070-0903-00). Cable, 18 inch, TRIGGER OUTPUT (012-0127-00).

TYPE 285 POWER SUPPLY, without Heads **$165**

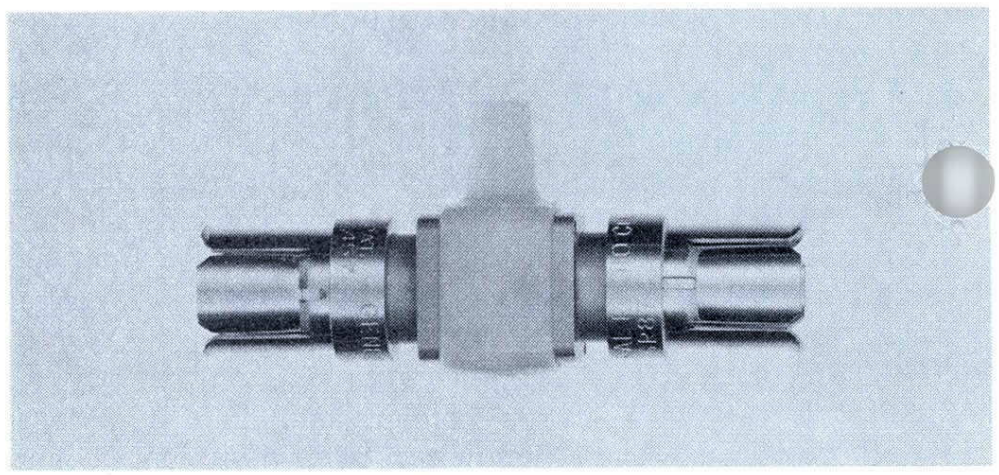
Sampling Accessories

With 3-mm Connectors

2X 50-Ω attenuator, order 015-1001-00	77
5X 50-Ω attenuator, order 015-1002-00	72
10X 50-Ω attenuator, order 015-1003-00	40
50-Ω termination, order 015-1004-00	40
2-ns 50-Ω signal cable, order 015-1005-00	40
5-ns 50-Ω signal cable, order 015-1006-00	20
Male-to-GR874 adapter, order 015-1007-00	20
Female-to-GR874 adapter, order 015-1008-00	40
Male-to-N female adapter, order 015-1009-00	105
Male-to-7-mm adapter, order 015-1010-00	9
Male-to-male adapter, order 015-1011-00	7
Female-to-female adapter, order 015-1012-00	75
Coupling capacitor, order 015-1013-00	94
50-Ω power divider T, order 015-1014-00	24
500-ps 50-Ω semi-rigid coax, order 015-1015-00	18
3-mm T adapter, order 015-1016-00	

With BNC Connectors

50-Ω feedthrough termination, order 011-0049-01	$10.00
50-Ω feedthrough (5 watt), order 011-0099-00	15.50
50-Ω 2X attenuator, order 011-0069-01	12.00
50-Ω 2.5X attenuator, order 011-0076-01	12.00
50-Ω 5X attenuator, order 011-0060-01	12.00
50-Ω 10X attenuator, order 011-0059-01	12.00
50-Ω, 18-in, coaxial cable, order 012-0076-00	5.80
50-Ω, 42-in, coaxial cable, order 012-0057-01	5.80



50 Ω Voltage Pickoff "T"

Type VP-2 is used in conjunction with the S-3 Direct Sampling Probe. The reflection coefficient without the S-3 Probe is approximately .04. With the probe inserted it is typically .06. All accessory heads supplied with the S-3 Probe can be used with the VP-2.

Order 017-0077-01 . . . . . $33

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Random Sampling Sweep

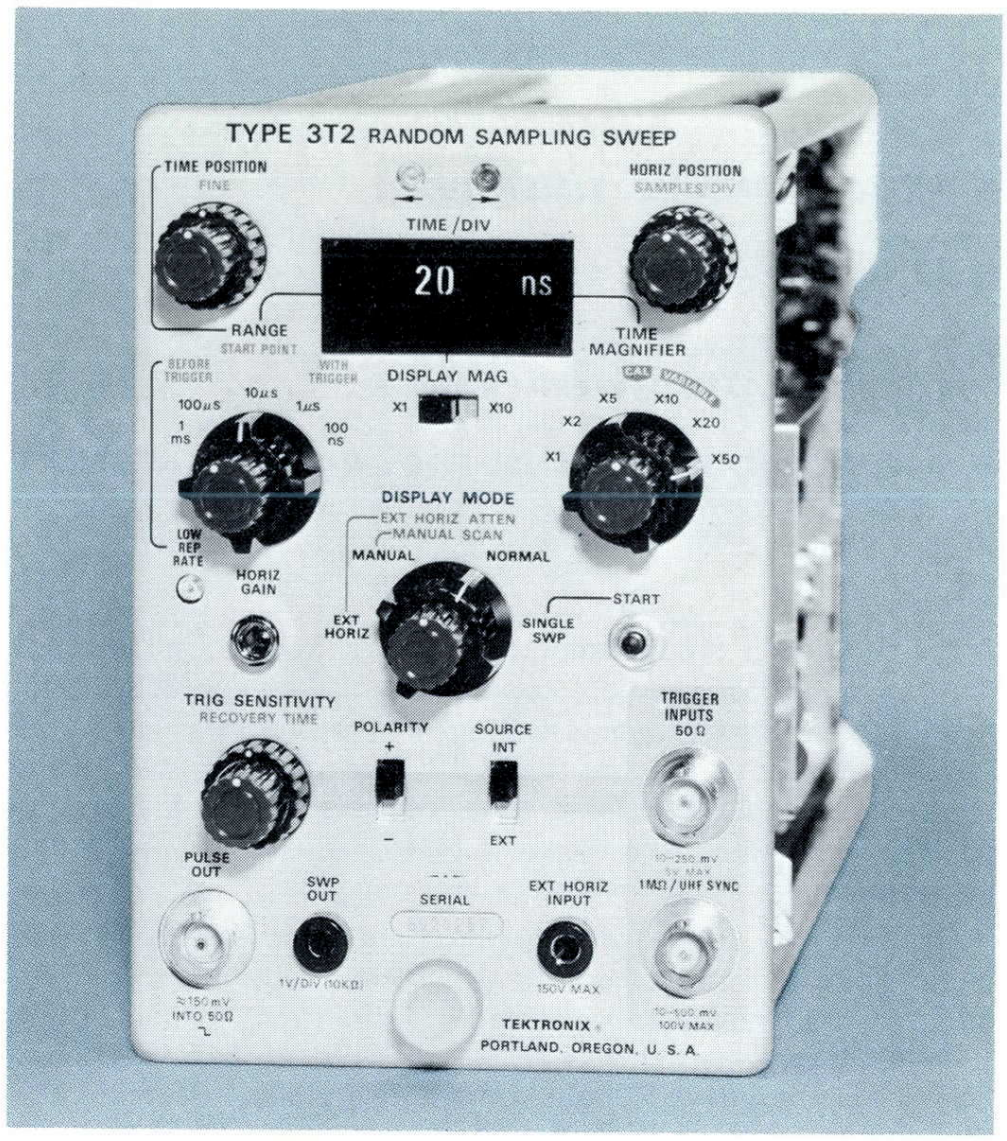
3T2

- ***RANDOM OR SEQUENTIAL SAMPLING***
- ***NO PRETRIGGER REQUIRED***
- ***20 ps/DIV-to-100 μs/DIV SWEEP RANGE***
- ***WIDE RANGE TIME POSITION***

The Type 3T2 Random Sampling Sweep Unit provides a unique, state-of-the-art advancement in measurement capabilities. This unit may be used in a Type 561B, 564B or 568 Oscilloscope, in conjunction with a Vertical Dual-Trace Sampling Unit.

Random sampling permits observation of the leading edge (or other portions) of signals even when used with vertical units that have no delay lines and without a pretrigger. Random sampling is especially useful with sampling units such as the Type 3S2 with S-1, S-2, S-3, S-4 or S-5 Sampling Heads.

A front-panel switch (START POINT) selects either conventional, sequentially-stepped sampling or random sampling modes of operation.



SWEEP TIME/DIV

100 μs/div to 200 ps/div, 1-2-5 sequence extending to 20 ps/div with X10 DISPLAY MAGNIFIER. Accurate within 3% from 100 μs/div to 2 ns/div, within 5% from 1 ns/div to 200 ps/div. TIME/DIV is a resultant of the combined settings of TIME POSITION RANGE, TIME MAGNIFIER, and DISPLAY MAG. The sweep rate is displayed (digitally) in the TIME/DIV "window" for all combinations of these controls.

DISPLAY MAG

X10 expansion of time scale while maintaining a constant number of dots per division. Display magnifier accurate within 2%, in addition to specified sweep time/div accuracy.

TIME POSITION RANGE

100 ns, 1 μs, 10 μs, 100 μs, and 1 ms. TIME POSITION and FINE variable controls position start of the display through an interval equal to TIME POSITION RANGE setting.

SAMPLES/DIV

Continuously variable adjustment of samples displayed per horizontal division from approx 5 samples/div to an immeasurable number of samples/div. Allows optimum adjustment of display rate and dot density.

DISPLAY MODES

Normal (repetitive), Single Sweep, Manual, or Ext. Horiz. For external input, deflection factor is adjustable from 1.5 V/div to 15 V/div. Front-panel START button for single-sweep operation.

PULSE OUTPUT

Approximately 150 mV into 50 Ω, negative going. Coincides with trigger recognition.

TRIGGERING

SOURCES (AC-coupled): Internal—if Sampling Unit contains a trigger pickoff. External, both 1-MΩ (for hi-Z probes) and 50-Ω terminated inputs.

JITTER: Depends on signal shape, repetition rate and amplitude; Less than or equal to 20 ps under optimum conditions.

HORIZONTAL OUTPUT

for each division of displayed signal through 10 kΩ.

PULSE TRIGGERING		
SOURCE	REPETITION RATE	AMPLITUDE*
EXTERNAL 1-MΩ/UHF Sync input	10 Hz to 100 MHz 600 MHz to 3 GHz	10 mV to 250 mV (100 V max DC)
EXTERNAL 50-Ω input	10 Hz to 600 MHz	5 mV to 125 mV (5 V max DC)
*Either polarity. Minimum rise rate is 150 mV/μs.		

SINEWAVE TRIGGERING		
SOURCE	FREQUENCY	AMPLITUDE
EXTERNAL 1-MΩ/UHF Sync input	10 kHz to 100 MHz 500 MHz to 3 GHz (+ polarity)	10 mV to 500 mV peak-to-peak
	100 kHz to 100 MHz 500 MHz to 3 GHz (— polarity)	
EXTERNAL 50-Ω input	100 kHz to 500 MHz	10 mV to 250 mV peak-to-peak

WEIGHTS

Net weight	6½ lb	3 kg
Domestic shipping weight	≈11 lb	≈5 kg
Export-packed weight	≈17 lb	≈7.7 kg

INCLUDED STANDARD ACCESSORIES

10X 50-Ω attenuator, BNC (011-0059-01); GR-to-BNC female adapter (017-0063-00); GR-to-BNC male adapter (017-0064-00); two instruction manuals (070-0631-00).

TYPE 3T2 RANDOM SAMPLING SWEEP UNIT $1100

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Programmable Sampling Sweep

3T5

- ***PROGRAMMABLE TIME/DIV***
- ***PROGRAMMABLE SWEEP DELAY***
- ***100 ps/DIV-to-500 ms/DIV CALIBRATED SWEEP RANGE***
- ***FRONT AND REAR PANEL PROGRAM CONNECTORS***

The Type 3T5 Programmable Sampling Sweep Unit extends the automatic measurement capabilities of the Type 568 Digital Readout Oscilloscopes, by allowing remote programming of the sampling sweep unit. The Type 3T5 can also be used in the Type 561B and Type 564B Oscilloscopes where it may be operated manually from the front panel, or externally programmed with the front panel program connector.

The time/div range, delay time range and samples/sweep of the Type 3T5 are externally programmed by means of parallel multipin connectors located on the front panel of the Type 3T5 and the rear panel of the Type 568 Oscilloscope (Serial Number B110000 and above). Digital delay and real-time sampling (1 ms/div to 500 ms/div) are controlled by a clock and digital counter within the plug-in unit. An automatic trigger mode is provided to eliminate the need for trigger adjustments over a wide range of trigger amplitudes, repetition rates, risetimes and pulse widths.

CHARACTERISTICS

SWEEP TIME/DIV

Remotely programmable or front-panel operation from 100 ps/div to 500 ms/div in 30 calibrated steps, 1-2-5 sequence. TIME/DIV "window" provides digital readout of all sweep time/div settings in both programmable and manual modes of operation. Programming is accomplished with 7 program lines. Accuracy is within 3% (within 5% from 100 ps/div to 500 ps/div), except for non-linearities at the beginning of the sweep, that can be programmed off screen.

SAMPLES/SWEEP

100 samples/sweep or 1000 samples/sweep are available in both the manual and external programming modes of operation. In the external program modes, the Type 230 Digital Unit can program the sweep unit to scan quickly (100 samples/sweep) when not making a measurement, but provides maximum measurement resolution (1000 samples/sweep) when making the measurement.

DELAY RANGE

The digital delay is remotely programmable or selectable from the front panel. The delay range is from 0 to 999.9 ns in 100-ps increments from 100 ps/div to 500 ps/div; 0 to 9.999 μs in 1-ns increments from 1 ns/div to 1 μs/div; 0 to 999.9 μs in 100-ns increments from 2 μs/div to 500 μs/div. Programming is accomplished with 16 program lines.

DELAY JITTER (All Sweep Speeds)

$\leq$0.1 div, independent of the amount of delay.

TRIGGERING

SOURCES: Internal, if sampling unit contains a trigger pick-off; External, 50-Ω terminated input.

JITTER: External automatic, pulse, 30 ps or less with 30[illegible] pulse, 2 ns or less wide; sinewave, 200 ps or less with 300-mV P-P signal at 30 MHz.

PULSE TRIGGERING		
SOURCE	FREQUENCY	AMPLITUDE
Internal	DC to 100 MHz	100 mV to 2 V
External	DC to 100 MHz	5 mV to 250 mV
External Automatic	DC to 100 MHz	100 mV to 500 mV
SINEWAVE TRIGGERING		
SOURCE	FREQUENCY	AMPLITUDE peak-to-peak
Internal	100 kHz to 100 MHz	100 mV to 2 V
External	1 Hz to 100 MHz	10 mV to 500 mV
External Sync	100 MHz to 1 GHz	10 mV to 150 mV
External Automatic	DC to 100 MHz	100 mV to 500 mV

WEIGHTS

Net weight	7 lb	3.2 kg
Domestic shipping weight	$\approx$10 lb	$\approx$4.5 kg
Export-packed weight	$\approx$14 lb	$\approx$6.3 kg

INCLUDED STANDARD ACCESSORIES

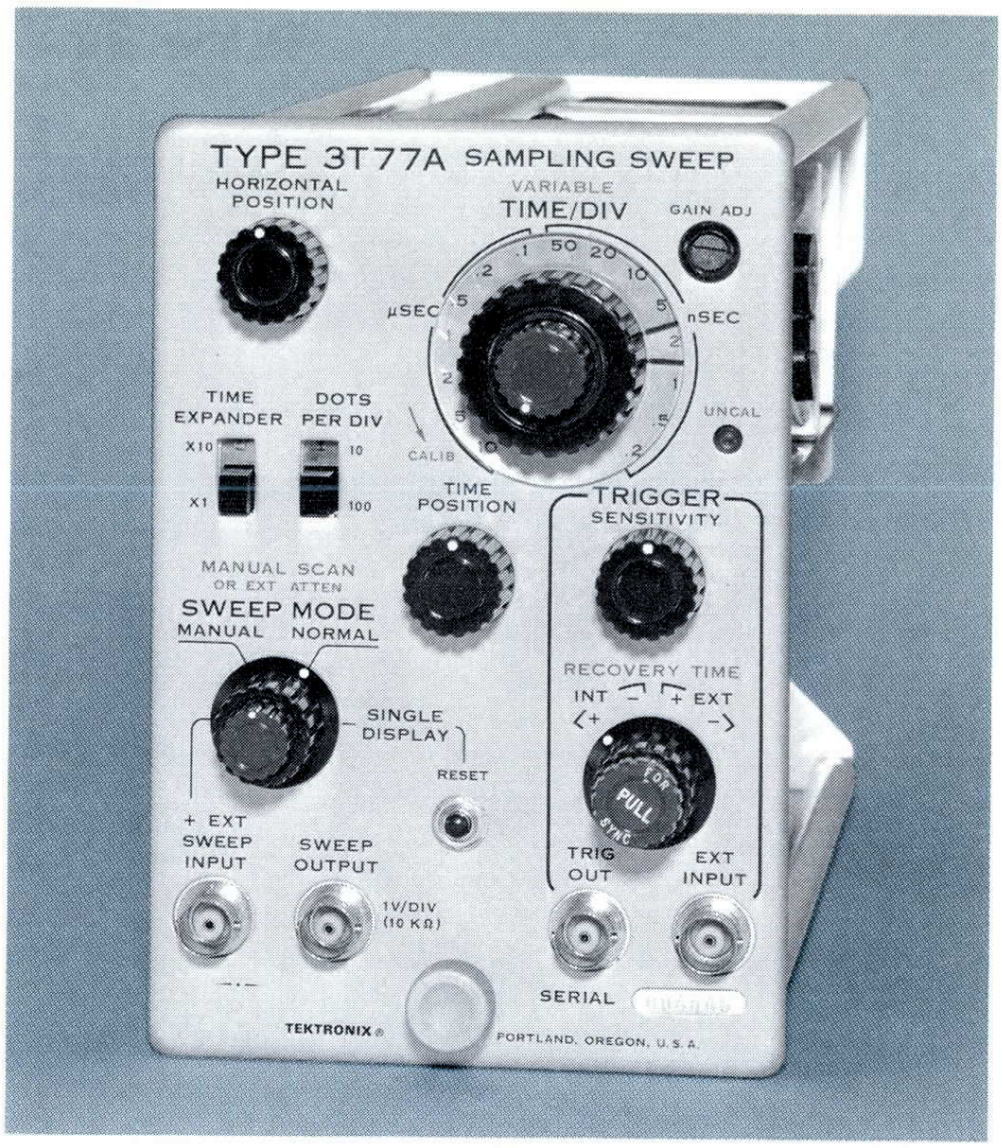
5-ns, 50-Ω RG58 cable with BNC connectors (012-0057-01); 10X 50-Ω BNC attenuator (011-0059-01); GR-to-BNC female adapter (017-0063-00); GR-to-BNC male adapter (017-0064-00); electrical connector (131-0422-00); electrical connector cover (200-0660-00); circuit board connector (388-0805-00); two instruction manuals (070-0760-00).

TYPE 3T5 SAMPLING UNIT $1800

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

- **TRIGGERING THROUGH 1 GHz**
- **20 ps/DIV-to-10 μs/DIV CALIBRATED TIME BASE**
- **WIDE-RANGE TIME POSITION**
- **SINGLE-DISPLAY PROVISION**
- **RECORDER OUTPUT**

The Type 3T77A Sampling Sweep Unit provides sub-nanosecond capabilities when used in conjunction with a Type 3S1, 3S2, 3S5 or 3S6 Sampling Unit in a Type 561B, 564B, or 568 Oscilloscope. In the Type 568 (with Type 230); information can be presented in digital as well as analog form.



CHARACTERISTICS

SWEEP TIME/DIV
10 μs/div to 200 ps/div in 15 calibrated steps, 1-2-5 sequence, extending to 20 ps/div with X10 TIME EXPANDER. Each step accurate within 3%. Variable between steps.

TIME EXPANDER
X10 expansion of time scale while maintaining a constant number of dots per division.

TIME POSITION
Provides a sweep delay range corresponding to at least one screen diameter, unexpanded and at least ten screen diameters (100 div) when expanded.

DOT DENSITY
Either 10 or 100 dots/div.

SWEEP MODES
Normal (repetitive), Single Sweep, Manual, or External Horizontal. For external input, deflection factor is adjustable from 5 V/div to 25 V/div. Front panel START button for single-sweep operation.

TRIGGERING
SOURCES (AC-coupled): Internal—if Sampling Unit contains a trigger pickoff. External, 50-Ω termination input.

AMPLITUDE (External): Sinewaves, 10 mV to 400 mV peak-to-peak; Pulses, 10 mV to 200 mV, either polarity. 5-V maximum DC input.

REPETITION RATE: Sinewave triggering or synchronizing from 100 kHz through 1 GHz. Pulse Triggering from 30 Hz through 1 GHz.

JITTER: Depends on signal shape, repetition rate and amplitude; less than or equal to 50 ps under optimum conditions.

TRIGGER OUTPUT
Approximately 150 mV into 50 Ω, positive going, coincides with trigger recognition.

SWEEP OUTPUT
1 V for each division of displayed signal through 10 kΩ.

WEIGHTS

Net weight	5¾ lb	2.6 kg
Domestic shipping weight	≈10¾ lb	≈4.9 kg
Export-packed weight	≈20 lb	≈9 kg

INCLUDED STANDARD ACCESSORIES
5-ns cable, RG58 with BNC connectors (012-0057-01); 10X 50-Ω BNC attenuator (011-0059-01); GR-to-BNC female adapter (017-0063-00); GR-to-BNC male adapter (017-0064-00); two instruction manuals (070-0546-00).

TYPE 3T77A SAMPLING SWEEP UNIT $800

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Type 530-540-550-580-Series Oscilloscopes and Plug-In Reference Information

The Tektronix Type 530-540-550-580-Series of laboratory plug-in oscilloscopes provide an unusually wide range of measurement capabilities. Oscilloscope mainframes are available which have one or more of the following features: Single time base, delayed sweep, alternate-sweep switching, dual beam, or storage. Real-time bandwidth of the mainframes is DC-to-15 MHz (Type 535A) to a maximum of 80 MHz (Type 585A). Any oscilloscope mainframe and the Type 1S1 sampling plug-in provide equivalent-time bandwidth to 1 GHz. The Mainframe Performance Chart identifies the significant features and bandwidth of individual instruments in this family.

Dual-beam performance is provided in two instruments, the Type 551 and Type 556. The Type 556 with its many operating modes and display features is one of today's most versatile oscilloscopes.

The Type 549 storage oscilloscope has the versatility of a delayed sweep/plug-in instrument *plus* storage writing speed of 5 cm/μs—a writing speed which clearly extends storage benefits beyond the usual low frequency applications to which many storage instruments are restricted. Consider these additional features of the Type 549: An Auto mode which frees the operator to devote his complete attention to the test point—up to one hour continuous viewing time—added convenience of writing rate which is variable between its normal and maximum limits—it simplifies many of the "just difficult to make" measurements—and others.

The 1-Series and Letter-Series plug-ins include single trace, multi-trace (up to 4), sampling, voltage comparator and/or differential, spectrum analyzers and special purpose units (see the Plug-In Performance Charts for details of each unit). The operator has a significant number of mainframe/plug-in combinations available such that he may select an instrument tailored to solve his particular measurement problems.

This series of instruments offer the user *proven performance* in one of the most respected, flexible, versatile oscilloscope systems presently available. Any instrument selected from this fully developed series represents a significant price/performance value which remains difficult to match.

TYPE 530-540-550-580-SERIES MAINFRAME PERFORMANCE CHART
APPLIES TO CABINET AND RACKMOUNT MODELS

MAINFRAME	BANDWIDTH	PAGE
535A Delayed Sweep	DC to 15 MHz	100
545B Delayed Sweep	DC to 33 MHz	107
544 Single Time Base	DC to 50 MHz	102
546 Delayed Sweep	DC to 50 MHz	102
547 Delayed/Alternate Sweep	DC to 50 MHz	102
549 Storage/Delayed Sweep	DC to 30 MHz	110
551 Dual Beam	DC to 27 MHz	114
556 Dual Beam/Delayed Sweep	DC to 50 MHz	116
585A Delayed Sweep	DC to 80 MHz	119

TYPE 530-540-550-580-SERIES MAINFRAME/PLUG-IN PERFORMANCE CHART
Bandwidth is in MHz unless noted otherwise. Risetime is in ns unless noted otherwise.

Note: The performance of these plug-ins, when used in combination with a Type 585A Oscilloscope and an 81A plug-in adapter, would be the same as those stated for DC to 50 MHz mainframes.

PLUG-IN	NUMBER OF CHANNELS	MINIMUM DEFLECTION FACTOR	DC to 15 MHz MAINFRAME		DC to 27 MHz MAINFRAME		DC to 30 MHz MAINFRAME		DC to 33 MHz MAINFRAME		DC to 50 MHz MAINFRAME		PAGE
			BW	T_R	BW	T_R	BW	T_R	BW	T_R	BW	T_R	
1A1	TWO	50 mV/cm 5 mV/cm $\simeq$500 μV/cm	DC to 15 DC to 14 2 Hz to 10	24 25 35	DC to 27 DC to 21 2 Hz to 13	13 17 27	DC to 30 DC to 23 2 Hz to 14	12 16 25	DC to 33 DC to 23 2 Hz to 14	11 16 25	DC to 50 DC to 28 2 Hz to 15	7 13 24	124
1A2	TWO	50 mV/cm	DC to 15	24	DC to 27	13	DC to 30	12	DC to 33	11	DC to 50	7	126
1A4	FOUR	10 mV/cm	DC to 15	24	DC to 27	13	DC to 30	12	DC to 33	11	DC to 50	7	127
L	ONE	50 mV/cm 5 mV/cm	DC to 15 3 Hz to 14	24 25	DC to 25 3 Hz to 22	14 16	DC to 27 3 Hz to 23	13 16	DC to 30 3 Hz to 24	12 15	DC to 30 3 Hz to 24	12 15	129

Type 530-540-550-580-Series Oscilloscopes and Plug-In Reference Information

DIFFERENTIAL AND COMPARATOR													
PLUG-IN	MAXIMUM CMRR	MINIMUM DEFLECTION FACTOR	DC - 15 MHz MAINFRAME		DC - 27 MHz MAINFRAME		DC - 30 MHz MAINFRAME		DC - 33 MHz MAINFRAME		DC - 50 MHz MAINFRAME		PAGE
			BW	T_R	BW	T_R	BW	T_R	BW	T_R	BW	T_R	
1A5	20,000:1	5 mV/cm 2 mV/cm 1 mV/cm	DC - 15 DC - 14 DC - 14	24 25 25	DC - 27 DC - 26 DC - 25	13 14 14	DC - 30 DC - 29 DC - 28	12 13 13	DC - 33 DC - 31 DC - 30	11 12 12	DC - 50 DC - 45 DC - 40	7 8 9	130
1A6	10,000:1	1 mV/cm	DC - 2	0.18 μs	DC - 2	0.18 μs	DC - 2	0.18 μs	DC - 2	0.18 μs	DC - 2	0.18 μs	132
1A7A	100,000:1	10 μV/cm	DC - 1	350	DC - 1	350	DC - 1	350	DC - 1	350	DC - 1	350	133
W	20,000:1	50 mV/cm 1 mV/cm	DC - 13 DC - 7	27 50	DC - 20 DC - 7.5	18 47	DC - 22 DC - 7	16 50	DC - 23 DC - 8	16 44	DC - 23 DC- 8	16 44	135

SAMPLING (Bandwidth is independent of mainframe bandwidth.)				
TYPE UNIT	MINIMUM DEFLECTION FACTOR	BW	T_R	PAGE
1S1 Sampling	2 mV/cm	DC - 1 GHz	350 ps	141
1S2 TDR and Sampling	5 mρ/cm 5 mV/cm	140 ps System Risetime DC - 3.9 GHz	90 ps	143

SPECTRUM ANALYZERS					
UNIT	MAXIMUM SENS	CENTER FREQUENCY RANGE	CAL. DISPERSION PER CM	RESOLUTION	PAGE
1L5	10 μV/cm	50 Hz-990 kHz	10 Hz - 100 kHz	10 Hz - 500 Hz	213
1L10	—100 dBm	1 MHz-36 MHz	10 Hz - 2 kHz	10 Hz - 1 kHz	217
1L20	—100 dBm	10 MHz-4.2 GHz	1 kHz - 10 MHz	1 kHz - 100 kHz	219
1L40	—110 dBm	1.5 GHz-40 GHz	1 kHz - 10 MHz	1 kHz - 100 kHz	219

SPECIAL PURPOSE				
TYPE UNIT	MINIMUM DEFLECTION FACTOR	INTERNAL Z_i	EXTERNAL Z_f	PAGE
O Two Channel op amp	50 mV/cm	0.01 - 1 MΩ	10 pF - 1 μF	137
Transducer Strain gage	10 μ strain/div	EXTERNAL ARMS 0 to 4	EQUIVALENT DC SENSITIVITY 10 μV/cm	139

Optional accessories expand measurement capabilities and provide added operating convenience. The following describes some of the accessories commonly used with these instruments. The Accessory Section of the catalog contains a complete description of all accessories.

CAMERAS

C-12 has beam-splitting mirror for straight-on viewing and use of optional projected graticule, f/1.9—1:0.85 lens, Polaroid* Land Pack-Film back accepts 3000-speed film.

C-27 provides direct viewing and maximum transmission of light to film, f/1.9—1:0.85 lens, Polaroid Land Pack-Film back accepts 3000-speed film.

Bezels for adapting Cameras to Oscilloscopes are listed in the Camera Accessory Section.

Polaroid Roll-Film back accepts 10,000-speed film for increased writing speed, can be substituted at no additional cost in either camera. Order C-12R or C-27R. Optional lenses are also available.

PROBES

The standard 10X probes supplied with the instrument satisfy most measurement requirements; however, optional probes (recommended on plug-in unit pages) may be better suited for particular applications.

SCOPE-MOBILE® CART

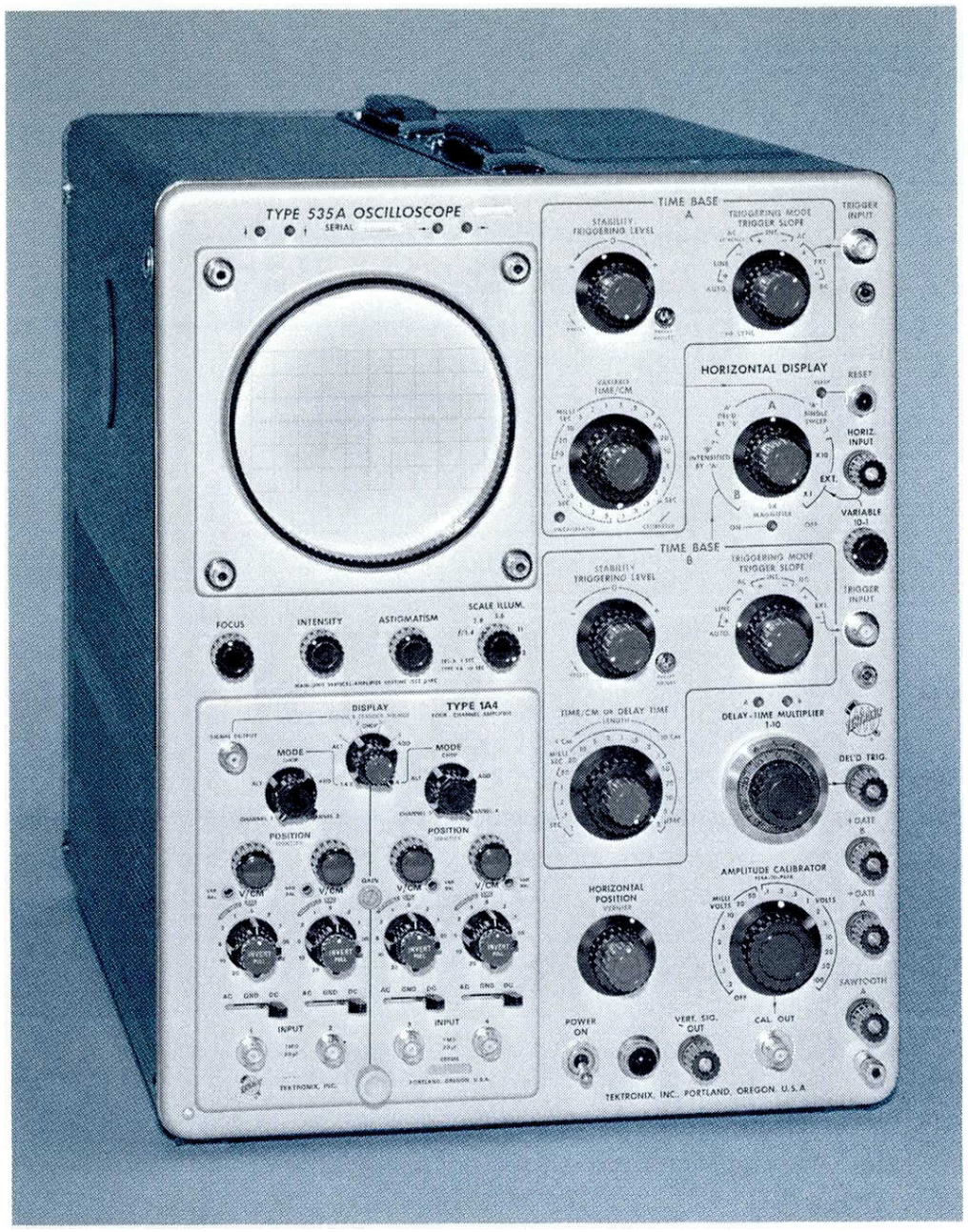
Model 202-2: storage drawer, carrier for 2 plug-in units, 9-position tilt-lock oscilloscope tray.

TV ACCESSORIES FOR GENERAL-PURPOSE OSCILLOSCOPES

In addition to the Tektronix line of television instruments, accessories are available for use with many Tektronix general-purpose oscilloscopes. A TV Sync Separator provides stable triggering for the display of composite video signals. A Video Staircase Differentiator allows the amplitude linearity of television systems and their components to be measured. See the catalog accessory pages for additional information.

*Registered Trademark, Polaroid Corporation

535A 15-MHz Oscilloscope RM35A



- ***CALIBRATED SWEEP DELAY***
- ***6 x 10-cm DISPLAY***
- ***ACCEPTS MULTI-TRACE, DIFFERENTIAL, SAMPLING, AND SPECTRUM ANALYZER PLUG-IN UNITS***

CHARACTERISTIC SUMMARY

VERTICAL

Vertical deflection characteristics are extremely flexible through use of all 1-Series and Letter-Series Plug-In Units.

HORIZONTAL

CALIBRATED TIME BASE—0.1 μs/cm to 5 s/cm.

X5 MAGNIFIER—Extends time base to 20 ns/cm.

CALIBRATED SWEEP DELAY—2 μs to 10 s.

EXTERNAL INPUT—0.2 V/cm to 2 V/cm, DC to 350 kHz.

CRT

DISPLAY AREA—6 x 10 cm.

ACCELERATING VOLTAGE—10 kV.

PHOSPHOR—P2

OTHER

AMPLITUDE CALIBRATOR—0.2 mV to 100 V (1-kHz square-wave).

POWER REQUIREMENTS—108, 115, 122, 216, 230, or 244 V (±9% on each range), 550 watts maximum.

VERTICAL DEFLECTION

BANDWIDTH
DC to 15 MHz at 3 dB down, depending on plug-in unit.

RISETIME
24 ns, depending on plug-in unit.

DELAY LINE
Permits viewing leading edge of displayed waveform.

SIGNAL OUTPUT
<10 Hz to >5 MHz at 3-dB down, no load (cathode follower output). At least 1.5 V for each centimeter of displayed signal.

HORIZONTAL DEFLECTION

TIME BASE A
0.1 μs/cm to 5 s/cm in 24 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 12 s/cm. Warning light indicates uncalibrated setting.

TIME BASE B
2 μs/cm to 1 s/cm in 18 calibrated steps (1-2-5 sequence), accurate within 3%. Sweep length continuously variable from 4 to 10 cm, allowing use of Time Base B as a repetition-rate generator from 0.1 Hz to 40 kHz.

X5 MAGNIFIER
Operates over full time base, increases fastest Time Base A rate to 20 ns/cm, and the fastest Time Base B rate to 0.4 μs/cm. Magnified time base accurate within 5%.

DELAYED SWEEP MODE
Delayed sweep starts after time interval determined by DELAY TIME and DELAY TIME MULTIPLIER. DELAY TIME CONTROL selects 2 μs to 1 s delay time in 1, 2, 5 sequence accurate to within 1% from 2 μs to 0.1 s and within 3% from 0.2 s to 1 s. DELAY TIME MULTIPLIER accurate within 0.2% of full scale. Provides calibrated time intervals from 0.10 to 10.00 times the DELAY TIME. Dial divided into 1,000 parts.

DIFFERENTIAL TIME MEASUREMENT ACCURACY
Within 1% and 4 minor divisions from 2 μs to 0.1 s and within 3% and 4 minor divisions from 0.2 s to 1 s. Jitter ≤1 part in 20,000 of 10 times DELAY TIME.

DELAY RANGE
0.2 μs to 10 s after start of delaying sweep.

DELAY MODES
Depending on the setting of the Delayed Sweep stability control, the Delayed Sweep can start immediately at end of delay time, or be triggerable at end of delay time (for jitter-free displays).

OPERATING MODES
Time Base A—Normal, single sweep, delayed by B.
Time Base B—Normal, intensified by A.

ERNAL INPUT

ixed steps of approx 0.2 V/cm and 2 V/cm, continuously variable between steps and to approx 20 V/cm, DC to ≥350 kHz at —3 dB. 50-V maximum input (DC + peak AC). Input RC approx 1 MΩ paralleled by approx 47 pF.

SIGNAL OUTPUTS

Gates from both time bases (positive going from 0 to at least +20 V), sawtooth from Time Base A (positive going from 0 to at least +130 V), and a delayed trigger pulse (positive going from 0 to at least +5 V). Cathode-follower outputs.

TRIGGER

MODES

Automatic mode or manual level selection; high-frequency sync on Time Base A. Automatic operation is useful between approx 50 Hz and 2 MHz, minimizes trigger adjustments for signals of different amplitudes, shapes, and repetition rates. With no input (or input less than 50 Hz), automatic triggering occurs at an approx 40-Hz rate, providing a convenient reference trace. High-frequency sync assures a steady display of sinewaves from less than 5 MHz to 30 MHz.

COUPLING

AC or DC; AC LF reject on Time Base A.

SOURCES

Internal (from oscilloscope vertical amplifier), external, or line. External trigger input RC approx 1 MΩ (91 kΩ at AC LF reject) paralleled by approx 40 pF for Time Base A, approx 1 MΩ paralleled by approx 50 pF for Time Base B.

TIME BASE A REQUIREMENTS

0.2-cm deflection or 0.2 V external from 150 Hz to 2 MHz, increasing to 1-cm deflection or 1 V external at 5 MHz. equirements increase below 150 Hz with AC coupling, below 10 kHz with AC low-frequency reject. DC coupling requires 0.4-cm deflection or 0.2 V external to 2 MHz, increasing to 2-cm deflection or 1 V external at 5 MHz. Automatic operation requires 0.4-cm deflection or 0.4 V external from 50 Hz to 1 MHz, increasing to 1-cm deflection or 1 V external at 2 MHz. High-frequency sync requires 2-cm deflection or 2 V external between approx 5 and 30 MHz. ±10-V trigger level range.

TIME BASE B REQUIREMENTS

0.2-cm deflection or 0.2 V external from 150 Hz to 1 MHz, increasing to 1-cm deflection or 1 V external at 3 MHz. Requirements increase below 150 Hz with AC coupling. DC coupling requires 0.4-cm deflection or 0.2 V external to 1 MHz, increasing to 2-cm deflection or 1 V external at 3 MHz. Automatic operation requires 0.4-cm deflection or 0.4 V external from 50 Hz to 1 MHz, increasing to 1-cm deflection or 1 V external at 2 MHz.

CRT

TEKTRONIX CRT

5-in metallized screen, helical post accelerating anode, 10-kV accelerating potential for bright displays. P2 phosphor normally supplied; P1, P7, P11, or P31 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. Z-axis input is AC coupled to CRT cathode, requires 20 V peak to peak for beam modulation at normal intensity.

GRATICULE

External; variable edge lighting. 6 x 10-cm display area. Vertical and horizontal center lines marked in 2-mm divisions.

PLAY FEATURES

eam-position indicators show direction of CRT beam when off screen. Multi-trace blanking eliminates switching transients from display when multi-trace plug-in unit is operated in chopped mode.

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR

0.2 mV to 100 V squarewave, 18 calibrated steps (1-2-5 sequence), accurate within 3%, approx 1-kHz repetition rate.

POWER REQUIREMENTS

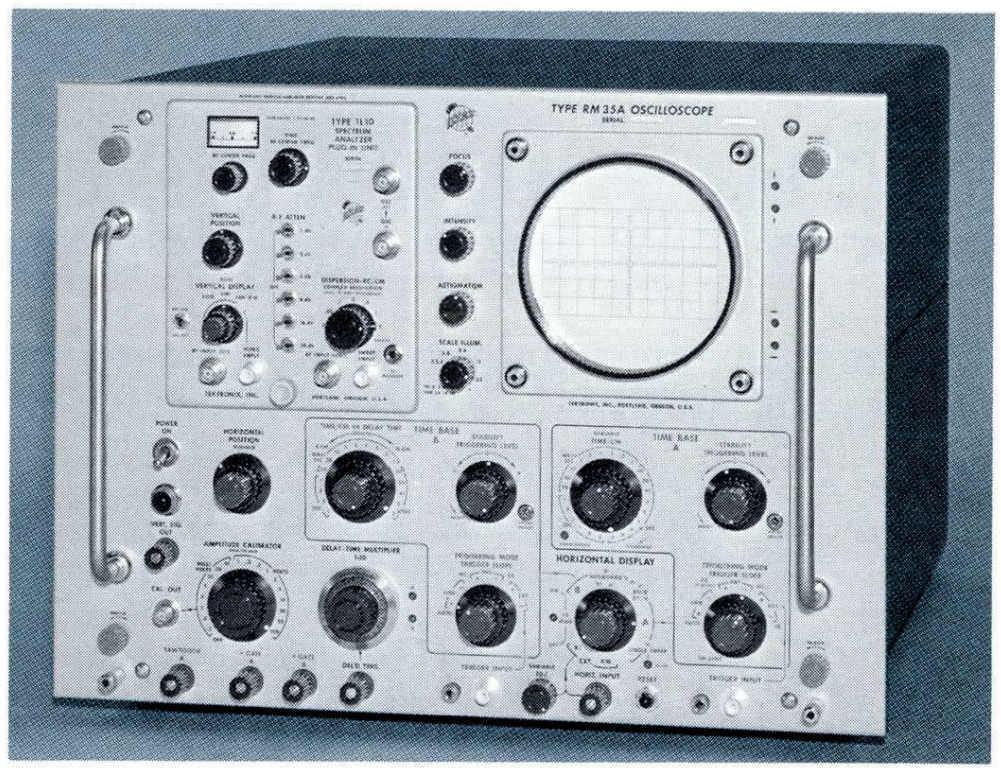
Wired for 115 V RMS ±9%; transformer taps permit operation at 108, 115, 122, 216, 230, or 244 V (±9% on each range); 50 to 60 Hz. 550-W maximum power consumption. Can be factory wired for any of the above nominal voltages, if so indicated on order.

CABINET MODEL DIMENSIONS AND WEIGHTS

Height	17 in	43.2 cm
Width	12 15/16 in	32.9 cm
Depth	23 7/8 in	60.7 cm
Net weight	61 1/4 lb	27.9 kg
Domestic shipping weight	≈ 80 lb	≈36.4 kg
Export-packed weight	≈100 lb	≈45.5 kg

RACK MODEL DIMENSIONS AND WEIGHTS

Height	14 in	35.6 cm
Width	19 in	48.3 cm
Rack depth	22 11/16 in	57.6 cm
Net weight	78 1/4 lb	35.6 kg
Domestic shipping weight	≈104 lb	≈47.3 kg
Export-packed weight	≈125 lb	≈56.8 kg



RACKMOUNTING

Type RM35A withdraws from its cabinet on slide-out tracks, tilts and locks in 7 positions. Further mounting information on catalog instrument dimensions page.

INCLUDED STANDARD ACCESSORIES

Two P6006 10X probes (010-0127-00); BNC-to-BNC 18-inch patch cord (012-0087-00); BNC-to-banana plug 18-inch patch cord (012-0091-00); BNC post jack (012-0092-00); 3 to 2-wire adapter (103-0013-00); 3-conductor power cord (161-0010-03); smoke-gray light filter (378-0567-00); two instruction manuals (070-0145-01). Type RM35A includes mounting hardware.

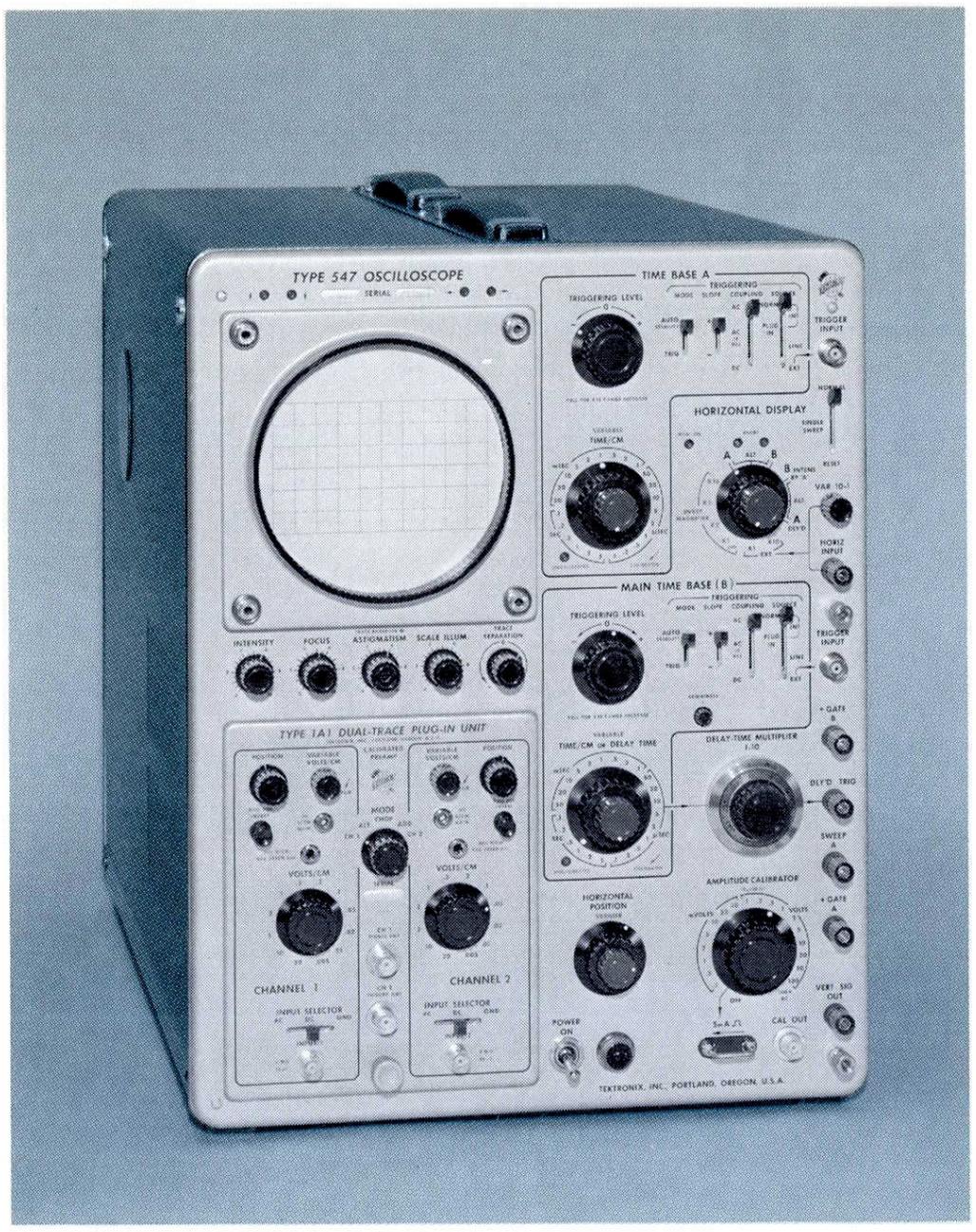
TYPE 535A OSCILLOSCOPE, without plug-in units **$1525**
TYPE RM35A OSCILLOSCOPE, without plug-in units **$1625**

OPTIONAL ACCESSORIES

Optional accessories expand measurement capabilities and provide added operating convenience. Camera, Probes, Scope-Mobile® Carts and other major accessories are completely described in the catalog accessory pages. Some of the accessories commonly used with the instrument are described in the Reference Section for this series.

U. S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

544/546/547 50-MHz Oscilloscopes RM544/RM546/RM547



- ***HORIZONTAL DISPLAYS***
  - ***544 Single Time Base***
  - ***546 Dual Time Base/Delayed Sweep***
  - ***547 Dual Time Base/Delayed Sweep/ Alternate Display***
- ***UNIFORM-FOCUS 6 x 10-cm DISPLAY***
- ***ILLUMINATED PARALLAX-FREE GRATICULE***
- ***FULL-BANDWIDTH TRIGGERING***
- ***ACCEPTS MULTI-TRACE, DIFFERENTIAL, SAMPLING, SPECTRUM ANALYZERS, AND SPECIAL PURPOSE PLUG-IN UNITS***

CHARACTERISTIC SUMMARY

VERTICAL

Vertical deflection characteristics are extremely flexible through use of all 1-Series and Letter-Series Plug-In Units.

HORIZONTAL

CALIBRATED TIME BASE—0.1 μs/cm to 5 s/cm.

SWEEP MAGNIFIER—X2, X5, or X10, extends calibrated time base to 10 ns/cm.

CALIBRATED SWEEP DELAY—0.1 μs to 50 s (applies to 546 and 547 only).

EXTERNAL INPUTS—0.1 V/cm to 1 V/cm, DC to 400 kHz (546 and 547 only).

0.1 V/cm to 10 V/cm, DC to 400 kHz (544 only).

CRT

DISPLAY AREA—6 x 10 cm.

ACCELERATING VOLTAGE—10 kV.

PHOSPHOR—P31

OTHER

AMPLITUDE CALIBRATOR—0.2 mV to 100 V, 1-kHz squarewave, 100 V DC, 5 mA DC, 5 mA 1-kHz squarewave.

POWER REQUIREMENTS—90 to 136 VAC or 180 to 272 VAC, 50 to 60 Hz, 550 watts.

The Types 544, 546, 547, and their rackmount configurations provide a wide performance range through mainframe and plug-in versatility.

The significant difference between the three instruments is the horizontal display capabilities. The 544 is a single time-base unit; the 546 is a dual time base, delayed sweep unit; the 547 is a dual time base, delayed sweep unit with horizontal display switching.

Display switching, within certain limitations, simulates dual-beam performance. For example, when using a multi-trace unit such as the 1A1, one plug-in channel may be locked to time base A and the other channel may be locked to time base B. This mode provides a dual display of two nonrelated signals.

Reference charts for this series contain information on the plug-ins available for these instruments.

544/546/547 50-MHz Oscilloscopes RM544/RM546/RM547

VERTICAL DEFLECTION
(Applies to 544/546/547)

BANDWIDTH
DC to 50 MHz at 3-dB down, depending on plug-in unit.

RISETIME
7 ns, depending on plug-in unit.

DELAY LINE
Permits viewing leading edge of displayed waveform.

SIGNAL OUTPUT
20-ns risetime, at least 0.3 V for each centimeter of displayed signal.

547 HORIZONTAL DEFLECTION

TIME BASE A AND B
0.1 μs/cm to 5 s/cm in 24 calibrated steps (1-2-5 sequence), accurate within 2%. Uncalibrated, continuously variable between steps and to approx 12 s/cm. Warning light indicates uncalibrated setting.

MAGNIFIER
X2, X5, or X10 magnification over full time-base, increases fastest rate to 10 ns/cm. Magnified time base accurate within 5%.

DELAYED SWEEP MODE
Delayed sweep starts after time interval determined by DELAY TIME and DELAY TIME MULTIPLIER. DELAY TIME CONTROL selects 0.1 μs to 5 s delay time in 1, 2, 5 sequence accurate to within 1%. DELAY TIME MULTIPLIER accurate within 0.2% of full scale. Provides calibrated time intervals from 0.15 to 10.00 times the DELAY TIME. Dial divided into 1,000 parts.

DIFFERENTIAL TIME MEASUREMENT ACCURACY
Within 1% and 4 minor divisions from 1 μs to 5 s and within 1% and 10 minor divisions from 0.1 μs to 0.5 μs. Jitter ≤1 part in 20,000 of 10 times DELAY TIME.

DELAY RANGE
0.1 μs to 50 s after start of delaying sweep.

DELAY MODES
Delayed sweep starts immediately at end of delay time, or is triggerable at end of delay time (for jitter-free displays).

DISPLAY MODES
Time Base A only, Time Base B only, A alternated with B, B intensified by A, A delayed by B, B intensified by A alternated with A delayed by B. Single sweep on all the A and the B sweep modes, can be reset at front panel or with ≥+20-V pulse with <0.5-μs risetime, through rear-panel connector.

EXTERNAL INPUT
Fixed steps of approx 0.1 V/cm and 1 V/cm, continuously variable between steps and to approx 10 V/cm, DC to ≥400 kHz at —3 dB. 50-V maximum input (DC + peak AC) in most sensitive position. Input RC approx 1 MΩ paralleled by approx 55 pF.

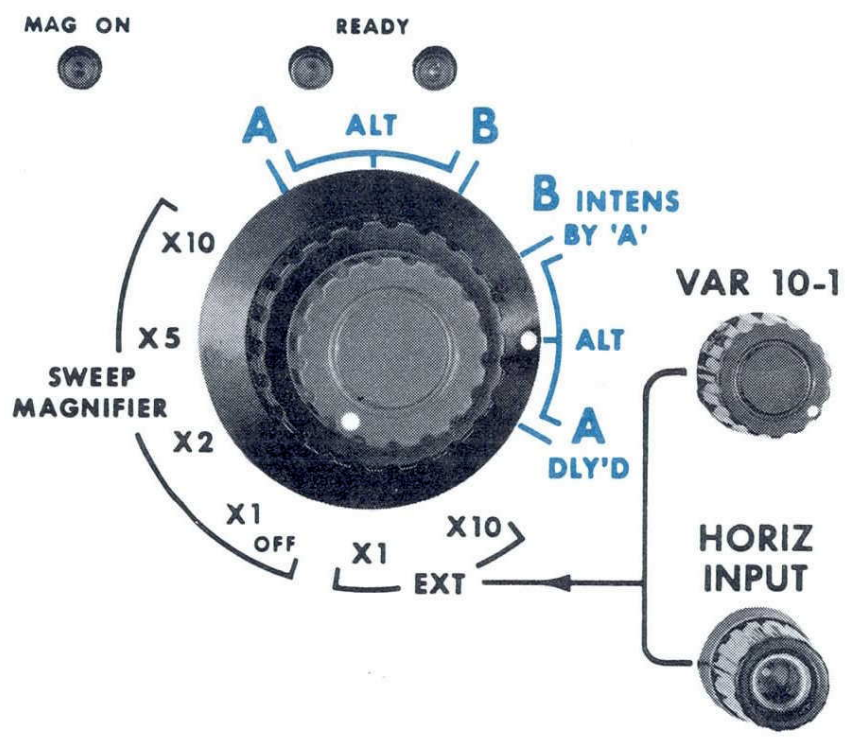
SIGNAL OUTPUTS
Gates from both time bases (positive going from 0 to at least +20 V), sawtooth from Time Base A (positive going from approx 0 to at least +90 V), and a delayed trigger pulse (positive going from 0 to at least +10 V).

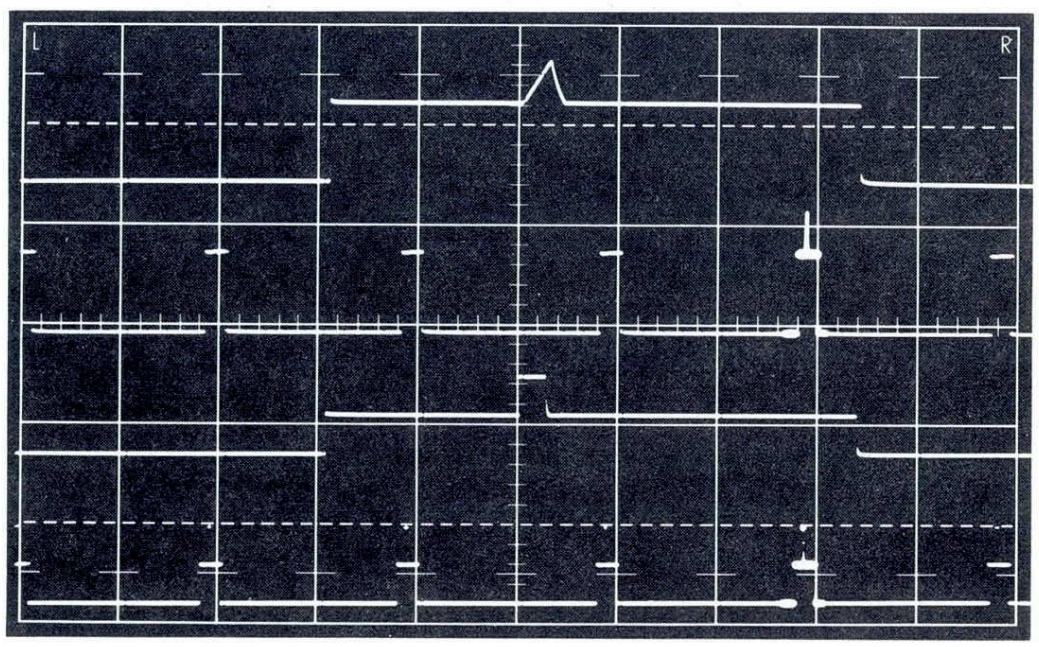
547 AUTOMATIC DISPLAY SWITCHING

Electronic switching between 2 wide-range time bases allows an alternate presentation of the same signal at 2 different sweep rates. Gallium Arsenide diodes in the switching circuit provide fast switching between time bases, and insure that only the desired time base is displayed at one time.

Two different signals can be alternately displayed at the same or different sweep rates with a Type 1A1 or 1A2 Dual-Trace Unit. With the Type 1A4 Four-Trace Unit, channels 1 and 2 can be locked to time base A, and channels 3 and 4 can be locked to time base B. In many applications, this provides equivalent dual-beam operation without the additional cost and complexity of a dual-beam oscilloscope. Dual displays are equal in quality to the finest single presentations. Also, the full 6 x 10-cm screen area can be used to display signals on either time base. A trace separation control operates in conjunction with the normal vertical position to allow full control of dual displays.

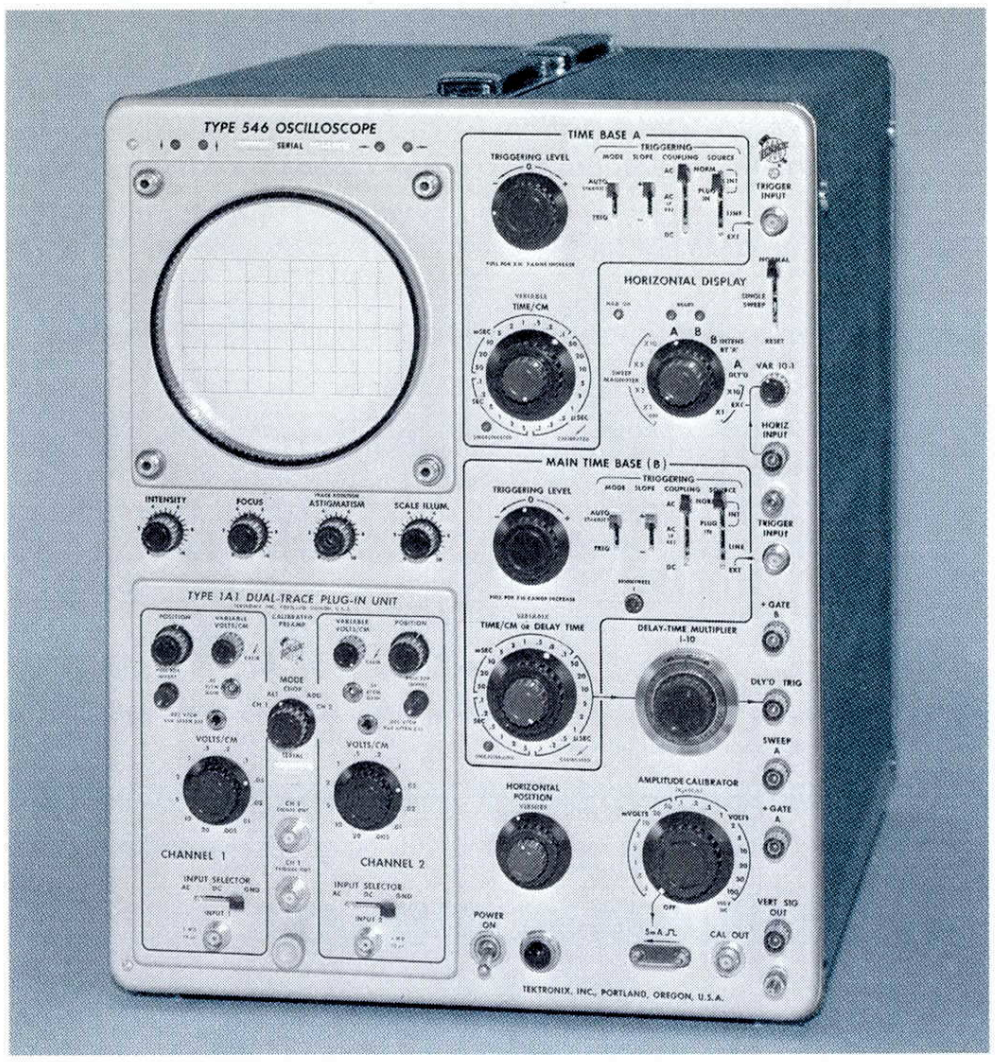
HORIZONTAL DISPLAY





Calibrated Sweep Delay—alternate presentation of 2 signals brightened over a selected portion, and the selected portions expanded to fill 10 cm.

544/546/547 50-MHz Oscilloscopes RM544/RM546/RM547



TYPE 546/DUAL TIME BASE/DELAYED SWEEP

546 HORIZONTAL DEFLECTION

TIME BASE A AND B

0.1 μs/cm to 5 s/cm in 24 calibrated steps (1-2-5 sequence), accurate within 2%. Uncalibrated, continuously variable between steps and to approx 12 s/cm. Warning light indicates uncalibrated setting.

MAGNIFIER

X2, X5, or X10 magnification over full time base, increases fastest rate to 10 ns/cm. Magnified time base accurate within 5%.

DELAYED SWEEP MODE

Delayed sweep starts after time interval determined by DELAY TIME and DELAY TIME MULTIPLIER. DELAY TIME CONTROL selects 0.1 μs to 5 s delay time in 1, 2, 5 sequence accurate to within 1%. DELAY TIME MULTIPLIER accurate within 0.2% of full scale. Provides calibrated time intervals from 0.15 to 10.00 times the DELAY TIME. Dial divided into 1,000 parts.

DIFFERENTIAL TIME MEASUREMENT ACCURACY

Within 1% and 4 minor divisions from 1 μs to 5 s and within 1% and 10 minor divisions from 0.1 μs to 0.5 μs. Jitter ≤1 part in 20,000 of 10 times DELAY TIME.

DELAY RANGE

0.1 μs to 50 s after start of delaying sweep.

DELAY MODES

Delayed sweep starts immediately at end of delay time, or is triggerable at end of delay time (for jitter-free displays).

DISPLAY MODES

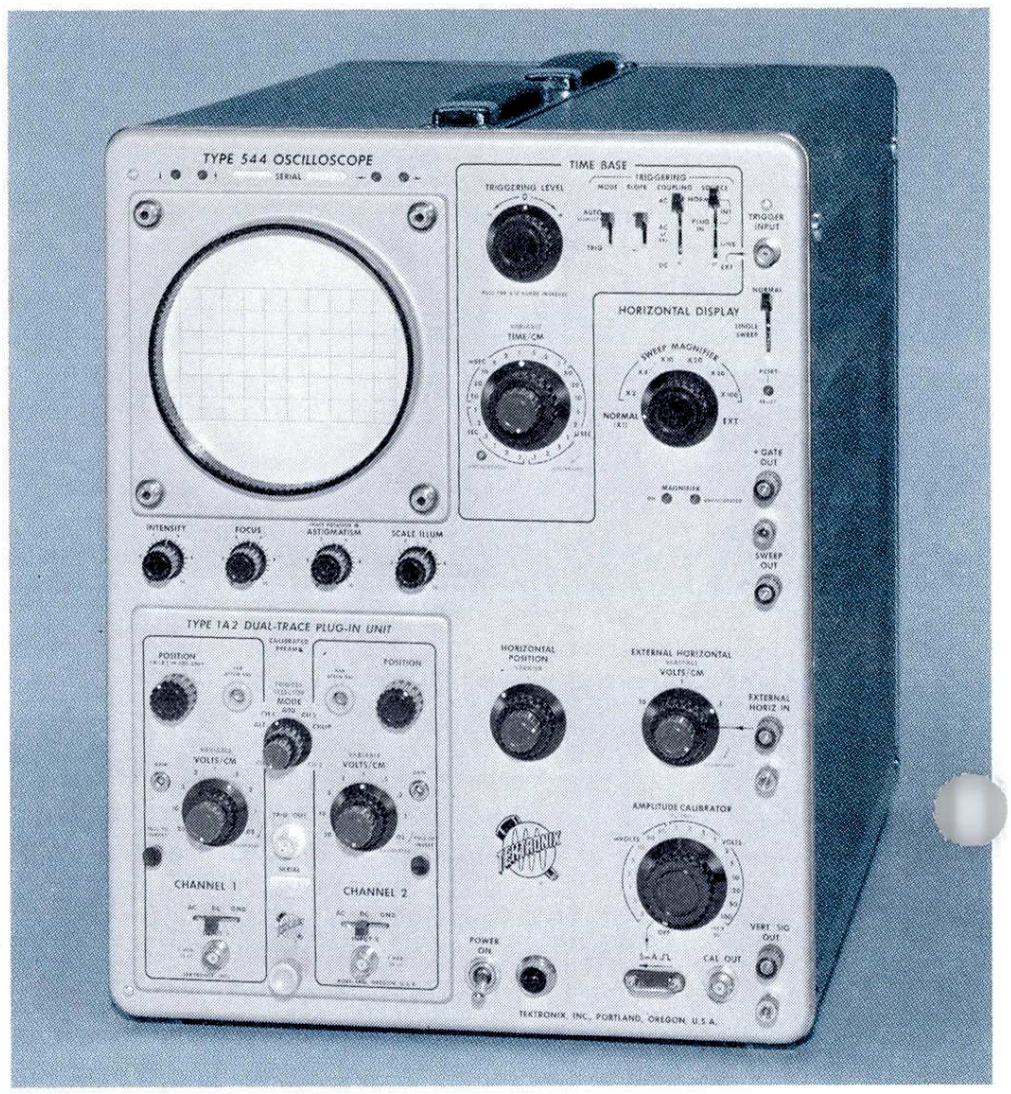
Time Base A—Normal, delayed by B, single sweep of both modes. Time Base B—Normal, intensified by A, single sweep of both modes. Single sweep reset at front panel or with ≥+20-V pulse with <0.5-μs risetime, through rear-panel connector.

EXTERNAL INPUT

Fixed steps of approx 0.1 V/cm and 1 V/cm, continuou[illegible] variable between steps and to approx 10 V/cm, DC to ≥[illegible] kHz at —3 dB. 50-V maximum input (DC + peak AC) in most sensitive position. Input RC approx 1 MΩ paralleled by approx 55 pF.

SIGNAL OUTPUTS

Gates from both time bases (positive going from 0 to at least +20 V), sawtooth from Time Base A (positive going from approx 0 to at least +90 V), and a delayed trigger pulse (positive going from 0 to at least +10 V).



TYPE 544/SINGLE TIME BASE

544 HORIZONTAL DEFLECTION

TIME BASE

0.1 μs/cm to 5 s/cm in 24 calibrated steps (1-2-5 sequence), accurate within 2%. Uncalibrated, continuously variable between steps and to approx 12 s/cm. Warning light indicates uncalibrated setting.

MAGNIFIER

X2, X5, X10, X20, X50 or X100 magnification. Magnified time base accurate within 5% up to 10 ns/cm. Warning light indicates if time base exceeds 10 ns/cm (uncalibrated).

OPERATING MODES

Normal, single sweep. Single sweep reset at front panel, or with ≥+20-V pulse with <0.5-μs risetime, through rear-panel connector.

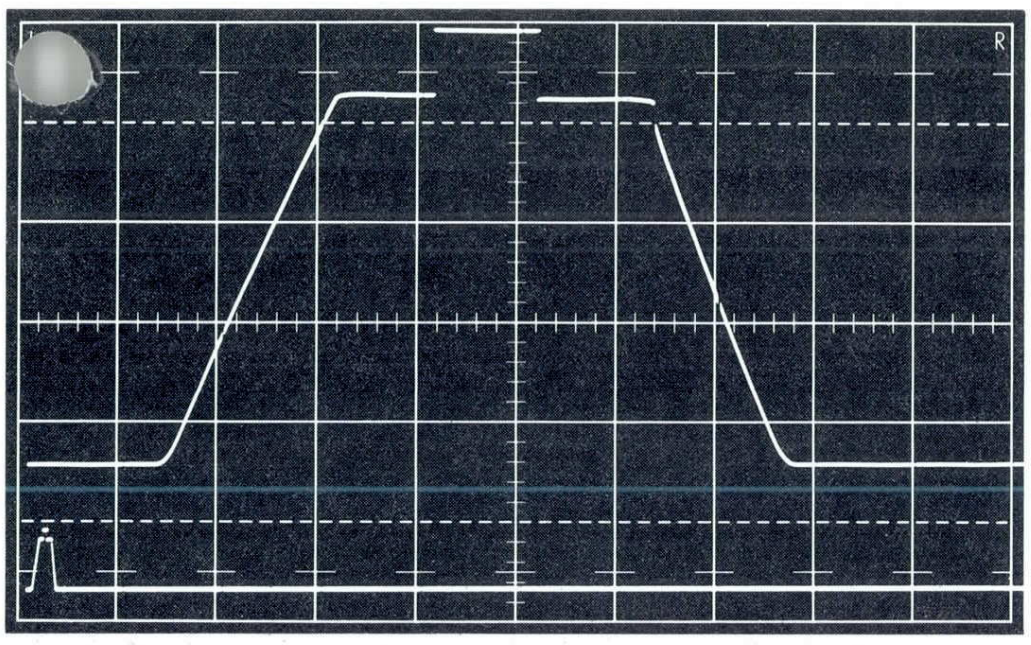
EXTERNAL INPUT

0.1, 1, and 10 V/cm, accurate within 5%. Uncalibrated, continuously variable between steps and to approx 100 V/cm. DC to ≥400 kHz at —3 dB. 50-V maximum input (DC + peak AC) in most sensitive position. Input RC approx 1 MΩ paralleled by approx 55 pF.

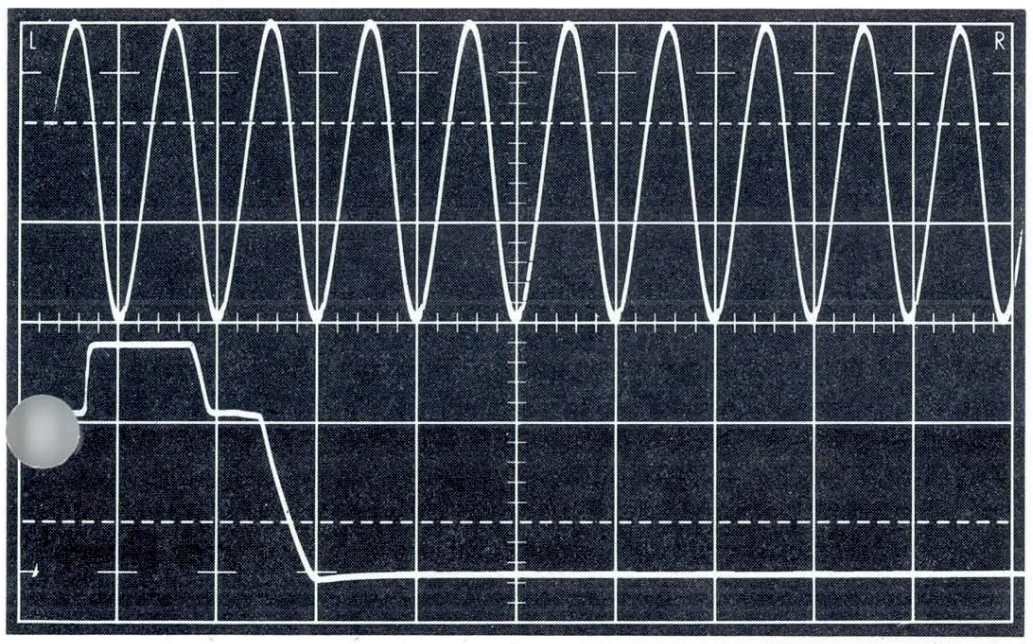
SIGNAL OUTPUTS

Gate (positive-going from 0 to at least +20 V) sawtooth (positive-going from 0 to at least +90 V).

544/546/547 50-MHz Oscilloscopes RM544/RM546/RM547



Vertical and Horizontal Expansion—same signal applied to both channels of the Type 1A1 Dual-Trace Unit with independent control of sensitivity and sweep rate in each channel.



Dual-Scope Operation—independent control of each signal with Channel 1 of the Type 1A1 Dual-Trace Unit locked to Time Base A, and Channel 2 locked to Time Base B.

These two photographs pertain to the 547 only.

TRIGGER

NOTE: The 544 has a single-trigger system. The 546 and 547 have two identical trigger systems, one for each time base.

MODES

Manual level selection with triggered or automatic operation. Automatic operation provides a convenient reference trace with no trigger-signal input, or repetition rates less than 20 Hz. Reference trace is bright throughout the full time-base range.

COUPLING

AC, DC, or AC LF reject.

SOURCES

Internal (from oscilloscope vertical amplifier or direct from a single channel of Type 1A1, 1A2 or 1A4 Plug-In Unit), external, or line. 30-V maximum external input (DC + peak AC). External trigger input RC approx 1.1 MΩ paralleled by approx 30 pF.

REQUIREMENTS

0.2-cm deflection or 0.2 V external at 1 kHz, increasing to 1-cm deflection or 0.2 V external at 50 MHz. Requirements increase below 2 kHz with AC low-frequency reject. DC coupling requires 0.5-cm deflection or 0.2 V external at DC to 50 MHz. ±2-V or ±20-V trigger level selection.

CRT

TEKTRONIX CRT

5-in metallized screen, helical post accelerating anode, 10-kV accelerating potential for bright displays. P31 phosphor normally supplied; P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. Z-axis input is AC coupled to CRT cathode, requires 15 V peak to peak for beam modulation at normal intensity.

GRATICULE

Internal, parallax-free; variable edge lighting. 6 x 10-cm display area. Vertical and horizontal center lines marked in 2-mm divisions. Two additional horizontal lines for convenient risetime measurements.

DISPLAY FEATURES

Beam-position indicators show direction of CRT beam when off screen. Multi-trace blanking eliminates switching transients from display when multi-trace plug-in unit is operated in chopped mode.

OTHER CHARACTERISTICS

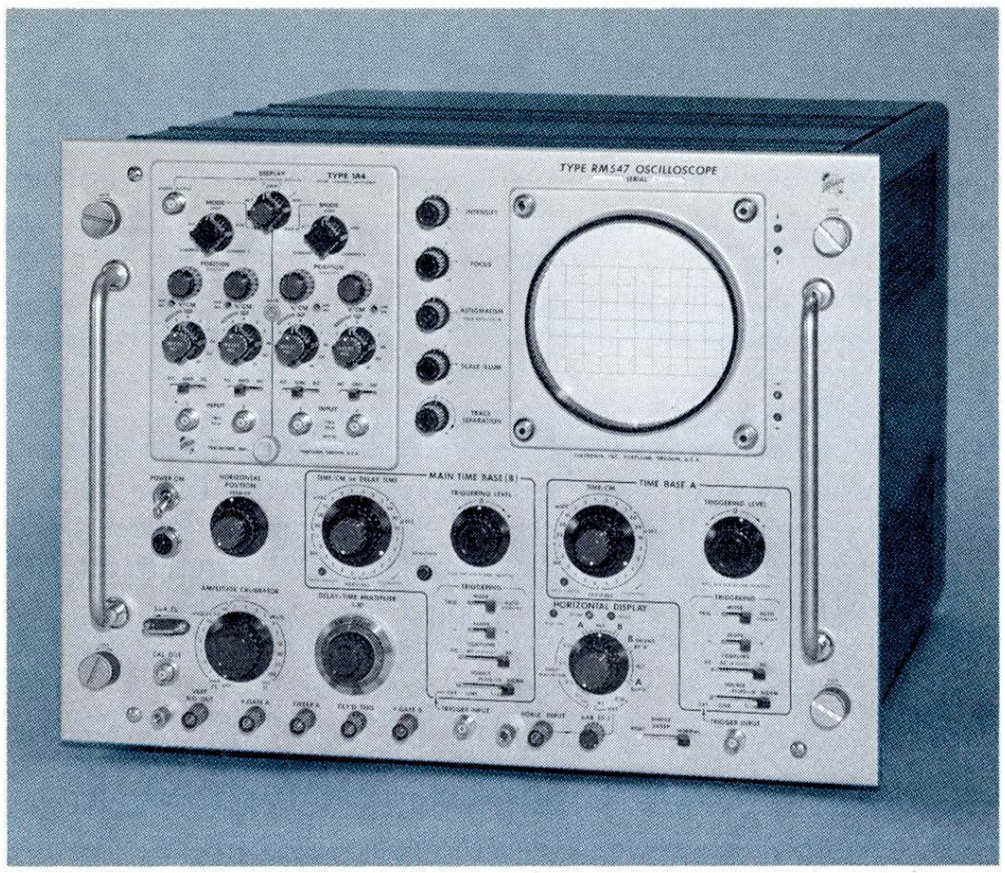
AMPLITUDE CALIBRATOR

0.2-mV to 100-V squarewave, 18 calibrated steps (1-2-5 sequence), accurate within 3%, approx 1-kHz repetition rate. 50-Ω source resistance from 0.2 mV to 0.2 V. 0.6-μs risetime from 0.2 mV to 5 V; 1-μs from 10 V to 100 V. 100-V DC reference output also provided. Front-panel current loop for 5 mA ±3%, squarewave or DC.

POWER REQUIREMENTS

90 to 136 VAC or 180 to 272 VAC, 50 to 60 Hz; 550 watts maximum at 115 V and 60 Hz. Rear panel selector provides rapid accommodation for six line-voltage ranges.

544/546/547 50-MHz Oscilloscopes RM544/RM546/RM547



TYPES RM544/RM546/RM547 RACKMOUNT CONFIGURATION

CABINET AND RACK MODEL DIMENSIONS AND WEIGHTS						
OSCILLOSCOPE	HEIGHT		WIDTH		DEPTH	
	IN	CM	IN	CM	IN	CM
544, 546, 547	17	43.2	$12\frac{15}{16}$	32.9	$23\frac{7}{8}$	60.7
R544, R546, R547	14	35.6	19	48.3	$22\frac{11}{16}$	57.6

OSCILLOSCOPE	NET WEIGHT		DOMESTIC SHIPPING WT		EXPORT-PACKED WT	
	LB	KG	LB (≃)	KG (≃)	LB (≃)	KG (≃)
544	61	27.8	80	36.4	97	44.1
546	$65\frac{1}{4}$	38.2	84	38.2	102	46.4
547	$65\frac{3}{4}$	29.9	85	38.6	103	46.8
R544	$82\frac{1}{4}$	37.4	106	42.2	130	59.1
R546	$85\frac{1}{2}$	38.9	112	51.0	136	61.8
R547	$86\frac{1}{4}$	39.2	114	51.8	137	62.3

RACKMOUNTING

Each of the rackmount instruments withdraws from its cabinet on slide-out tracks, tilts and locks in seven positions. Further mounting information on catalog instruments dimension page.

INCLUDED STANDARD ACCESSORIES

Two P6008 10X probes (010-0129-00); BNC-to-banana [illegible] 18-inch patch cord (012-0091-00); BNC-post jack (012-0092-[illegible]); 3 to 2-wire adapter (103-0013-00); smoke-gray light filter, installed (378-0567-00); clear CRT protector plate (387-0918-00); BNC-to-BNC 18-inch patch cords (012-0087-00); two with 544 and three with 546 and 547; two instruction manuals, 544 (070-0418-00); 546 (070-0367-00); 547 (070-0398-00). Each rack-mount includes mounting hardware.

TYPE 544 OSCILLOSCOPE, without plug-in units . **$1,625**

TYPE RM544 OSCILLOSCOPE, without plug-in units **$1,725**

TYPE 546 OSCILLOSCOPE, without plug-in units . **$1,825**

TYPE RM546 OSCILLOSCOPE, without plug-in units **$1,925**

TYPE 547 OSCILLOSCOPE, without plug-in units . **$1,950**

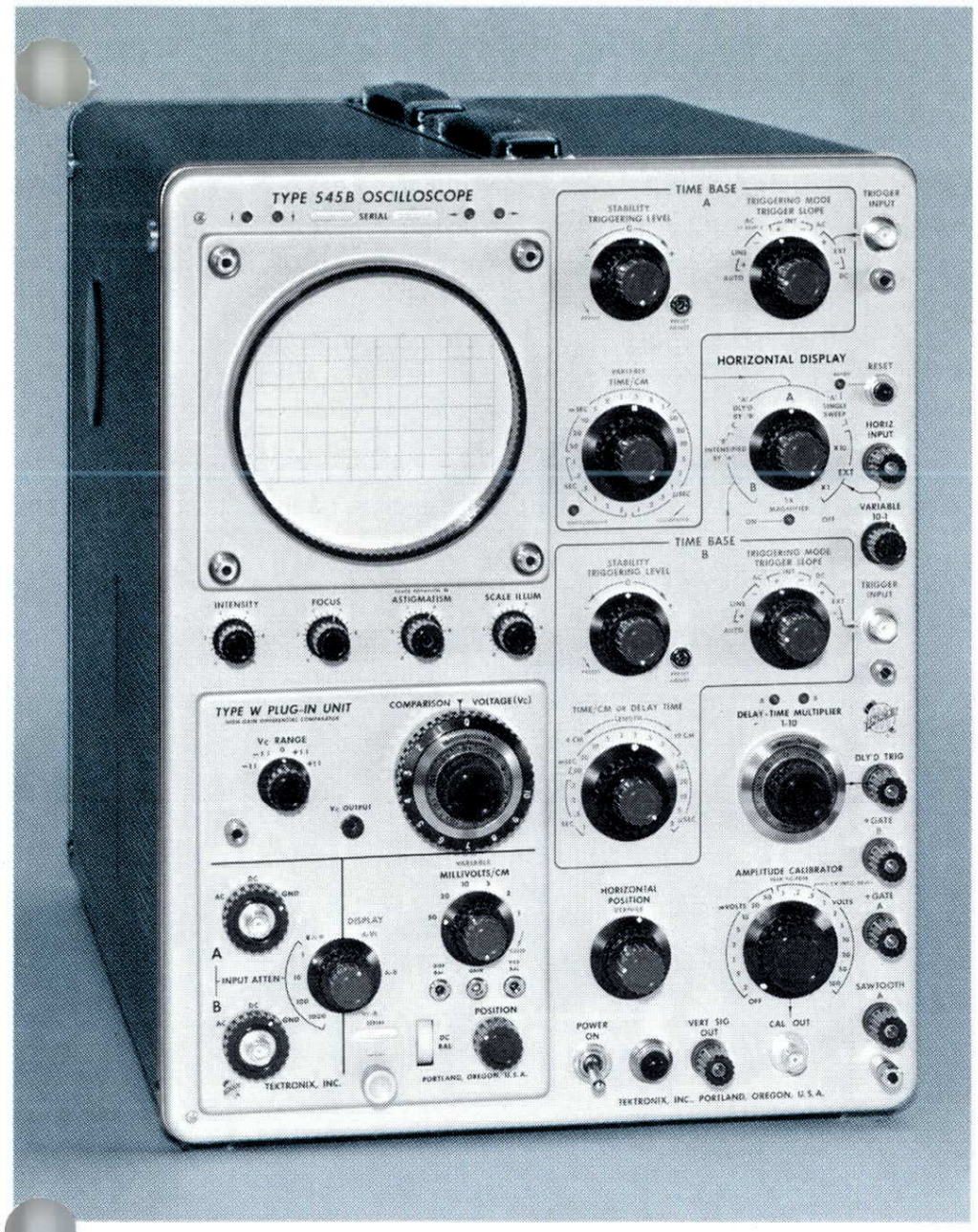
TYPE RM547 OSCILLOSCOPE, without plug-in units **$2,050**

OPTIONAL ACCESSORIES

Optional accessories expand measurement capabilities and provide added operating convenience. Camera, Probes, Scope-Mobile® Carts and other major accessories are completely described in the catalog accessory pages. Some of the accessories commonly used with this instrument are described in the Reference Section for this series.

U. S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

545B 33-MHz Oscilloscope RM545B



- *CALIBRATED SWEEP DELAY*
- *UNIFORM-FOCUS 6 x 10-cm DISPLAY*
- *ILLUMINATED PARALLAX-FREE GRATICULE*
- *FULL-BANDWIDTH TRIGGERING*
- *ACCEPTS MULTI-TRACE, DIFFERENTIAL, SAMPLING, AND SPECTRUM ANALYZER PLUG-IN UNITS*

The Type 545B and RM545B are versatile laboratory oscilloscopes designed for use with all Tektronix Letter-Series and 1-Series Plug-In Units.

Two separate time-base generators can be used in delayed-sweep operation for highly-accurate time measurements.

CHARACTERISTIC SUMMARY

VERTICAL

Vertical deflection characteristics are extremely flexible through use of all 1-Series and Letter-Series Plug-In Units.

HORIZONTAL

CALIBRATED TIME BASE—0.1 μs/cm to 5 s/cm. Time Base B 2 μs/cm to 1 s/cm.

X5 MAGNIFIER—Extends time base to 20 ns/cm.

CALIBRATED SWEEP DELAY—2 μs to 10 s.

EXTERNAL INPUT—0.2 V/cm, DC to 350 kHz.

CRT

DISPLAY AREA—6 x 10 cm.

ACCELERATING VOLTAGE—10 kV.

PHOSPHOR—P31

OTHER

AMPLITUDE CALIBRATOR—0.2 mV to 100 V, 1-kHz square-wave.

POWER REQUIREMENTS—90 to 136 VAC or 180 to 272 VAC, 50 to 60 Hz, 500 watts.

VERTICAL DEFLECTION

BANDWIDTH
DC to 33 MHz at 3-dB down, depending on plug-in unit.

RISETIME
11 ns, depending on plug-in unit.

DELAY LINE
Permits viewing leading edge of displayed waveform.

SIGNAL OUTPUT
Approx 1.2 V for each centimeter of displayed signal.

HORIZONTAL DEFLECTION

TIME BASE A
0.1 μs/cm to 5 s/cm in 24 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 12.5 s/cm. Warning light indicates uncalibrated setting.

TIME BASE B
2 μs/cm to 1 s/cm in 18 calibrated steps (1-2-5 sequence), accurate within 3%. Sweep length continuously variable from 4 to 10 cm, allowing use of Time Base B as a repetition-rate generator from 0.1 Hz to 40 kHz.

X5 MAGNIFIER
Operates over full time base, increases fastest Time Base A rate to 20 ns/cm, and the fastest Time Base B rate to 0.4 μs/cm. Magnified time base accurate within 5%.

DELAYED SWEEP MODE

Delayed sweep starts after time interval determined by DELAY TIME and DELAY TIME MULTIPLIER. DELAY TIME CONTROL selects 2 μs to 1 s delay time in a 1, 2, 5 sequence accurate to within 1%. DELAY TIME MULTIPLIER accurate within 0.2% of full scale. Provides calibrated time intervals from 0.10 to 10.00 times the DELAY TIME. Dial divided into 1,000 parts.

DIFFERENTIAL TIME MEASUREMENT ACCURACY

Within 1% and 4 minor divisions. Jitter ≤ 1 part in 20,000 of 10 times DELAY TIME.

DELAY RANGE

0.2 μs to 10 s after start of delaying sweep.

DELAY MODES

Depending on the setting of the Delayed Sweep stability control, the Delayed Sweep can start immediately at end of delay time, or be triggerable at end of delay time (for jitter-free displays).

OPERATING MODES

Time Base A—Normal, single sweep, delayed by B.
Time Base B—Normal, intensified by A.

EXTERNAL INPUT

Fixed steps of approx 0.2 V/cm and 2 V/cm, continuously variable between steps and to approx 20 V/cm, DC to ≥350 kHz at —3 dB. 50-V maximum input (DC + peak AC). Input RC approx 1 MΩ paralleled by approx 45 pF.

SIGNAL OUTPUTS

Gates from both time bases (positive going from 0 to at least +20 V), sawtooth from Time Base A (positive going from 0 to at least +130 V), and a delayed trigger pulse (positive going from 0 to at least +5 V).

TRIGGER

MODES

Automatic mode or manual level selection. Automatic operation is useful between approx 50 Hz and 10 MHz, minimizes trigger adjustments for signals of different amplitudes, shapes, and repetition rates. With no input (or input less than 50 Hz), automatic triggering occurs at an approx 40-Hz rate, providing a convenient reference trace.

COUPLING

AC or DC; AC LF reject on Time Base A.

SOURCES

Internal (from oscilloscope vertical amplifier), external, or line. 50-V maximum external input (DC + peak AC). External trigger input RC approx 1 MΩ (91 kΩ at AC LF reject) paralleled by approx 25 pF for Time Base A, approx 1 MΩ paralleled by approx 47 pF for Time Base B.

TIME BASE A REQUIREMENTS

0.2-cm deflection or 0.2 V external from 150 Hz to 10 MHz increasing to 1-cm deflection or 1 V external at 30 MHz. Requirements increase below 30 kHz with AC low-frequency reject. DC coupling requires 0.6-cm deflection or 0.2 V external to 10 MHz. Automatic operation requires 0.5-cm deflection or 0.5 V external at 150 Hz, increased deflection to 10 MHz.

TIME BASE B REQUIREMENTS

0.2-cm deflection or 0.2-V external at 300 Hz to 5 MHz, increasing to 1-cm deflection or 1-V external at 10 MHz. Requirements increase below 300 Hz with AC coupling. DC coupling requires 0.6-cm deflection or 0.2-V external to 5 MHz. Automatic operation requires 0.5-cm deflection or 0.5-V external at 300 Hz, will trigger from 50 Hz to 5 MHz with increased signal.

CRT

TEKTRONIX CRT

5-in metallized screen, helical post accelerating anode. 10-kV accelerating potential for bright displays. P31 phosphor normally supplied; P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative or Distributor for application information and availability. Z-axis input is AC coupled to CRT cathode, requires 15 V peak to peak for beam modulation at normal intensity.

GRATICULE

Internal, parallax-free; variable edge lighting. 6 x 10-cm display area. Vertical and horizontal center lines marked in 2-mm divisions. Two additional horizontal lines for convenient risetime measurements.

DISPLAY FEATURES

Beam-position indicators show direction of CRT beam when off screen. Multi-trace blanking eliminates switching transients from display when multi-trace plug-in unit is operated in chopped mode.

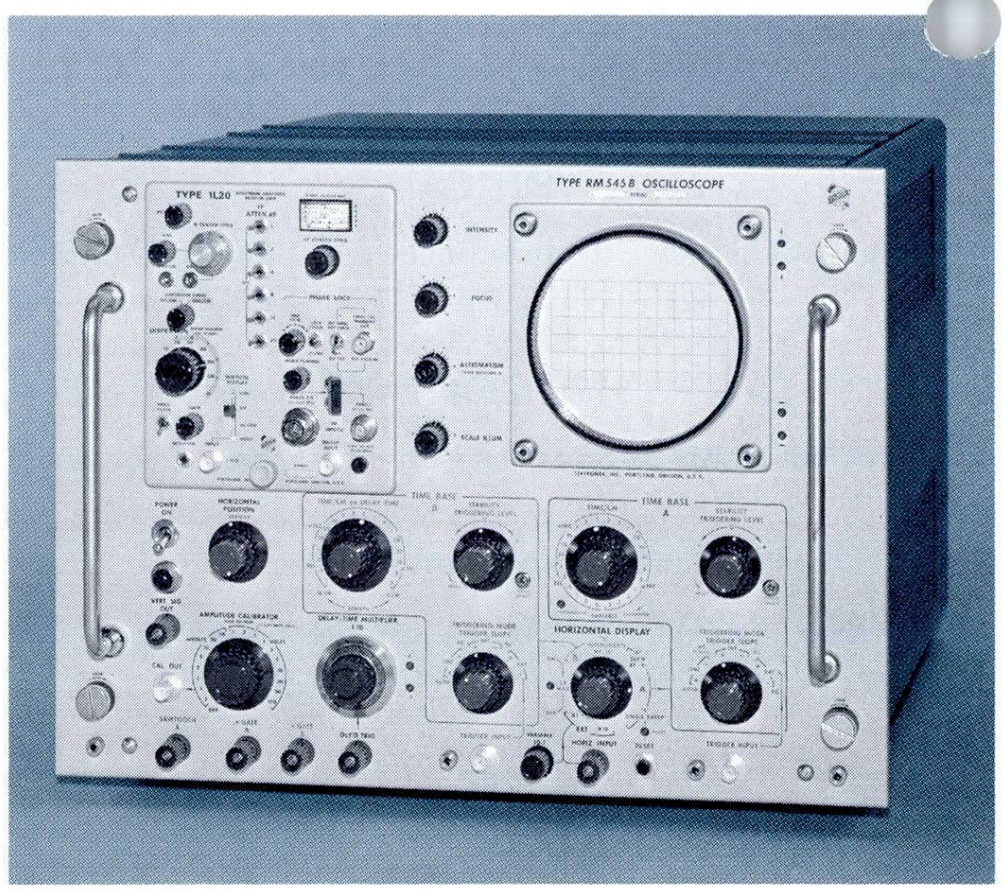
OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR

0.2-mV to 100-V squarewave, 18 calibrated steps (1-2-5 sequence), accurate within 3%, approx 1-kHz repetition rate. Special output, useful in calibrating sampling plug-ins, provides 0.1 V ±3% into 50 Ω.

POWER REQUIREMENTS

90 to 136 VAC or 180 to 272 VAC, 50 to 60 Hz; 500 watts maximum at 115 V and 60 Hz. Rear panel selector provides rapid accommodation for six line-voltage ranges.



RACK MODEL DIMENSIONS AND WEIGHTS

Height	14 in	35.6 cm
Width	19 in	48.3 cm
Rack depth	$22\frac{11}{16}$ in	57.6 cm
Net weight	85 lb	38.6 kg
Domestic shipping weight	≈111 lb	≈50.5 kg
Export-packed weight	≈130 lb	≈59.1 kg

RACKMOUNTING

Type RM545B withdraws from its cabinet on slide-out tracks, tilts and locks in 7 positions. Further mounting information on catalog instrument dimension page.

CABINET MODEL DIMENSIONS AND WEIGHTS

Height	17 in	43.2 cm
Width	$12\frac{15}{16}$ in	32.9 cm
Depth	$23\frac{7}{8}$ in	60.7 cm
Net weight	64 lb	29.1 kg
Domestic shipping weight	≈82 lb	≈37.3 kg
Export-packed weight	≈101 lb	≈45.9 kg

INCLUDED STANDARD ACCESSORIES

Two P6006 10X probes (010-0127-00); BNC-to-BNC 18-inch 50-Ω cable (012-0076-00); two BNC-to-BNC 18-inch patch cords (012-0087-00); BNC-to-banana plug 18-inch patch cord (012-0091-00); BNC-post jack (012-0092-00); 3 to 2-wire adapter (103-0013-00); smoke-gray light filter, installed (378-0567-00); clear CRT protector plate (387-0918-00); two instruction manuals (070-0428-02). Type RM545B also includes mounting hardware.

TYPE 545B OSCILLOSCOPE, without plug-in units **$1,700**

TYPE RM545B OSCILLOSCOPE, without plug-in units **$1,800**

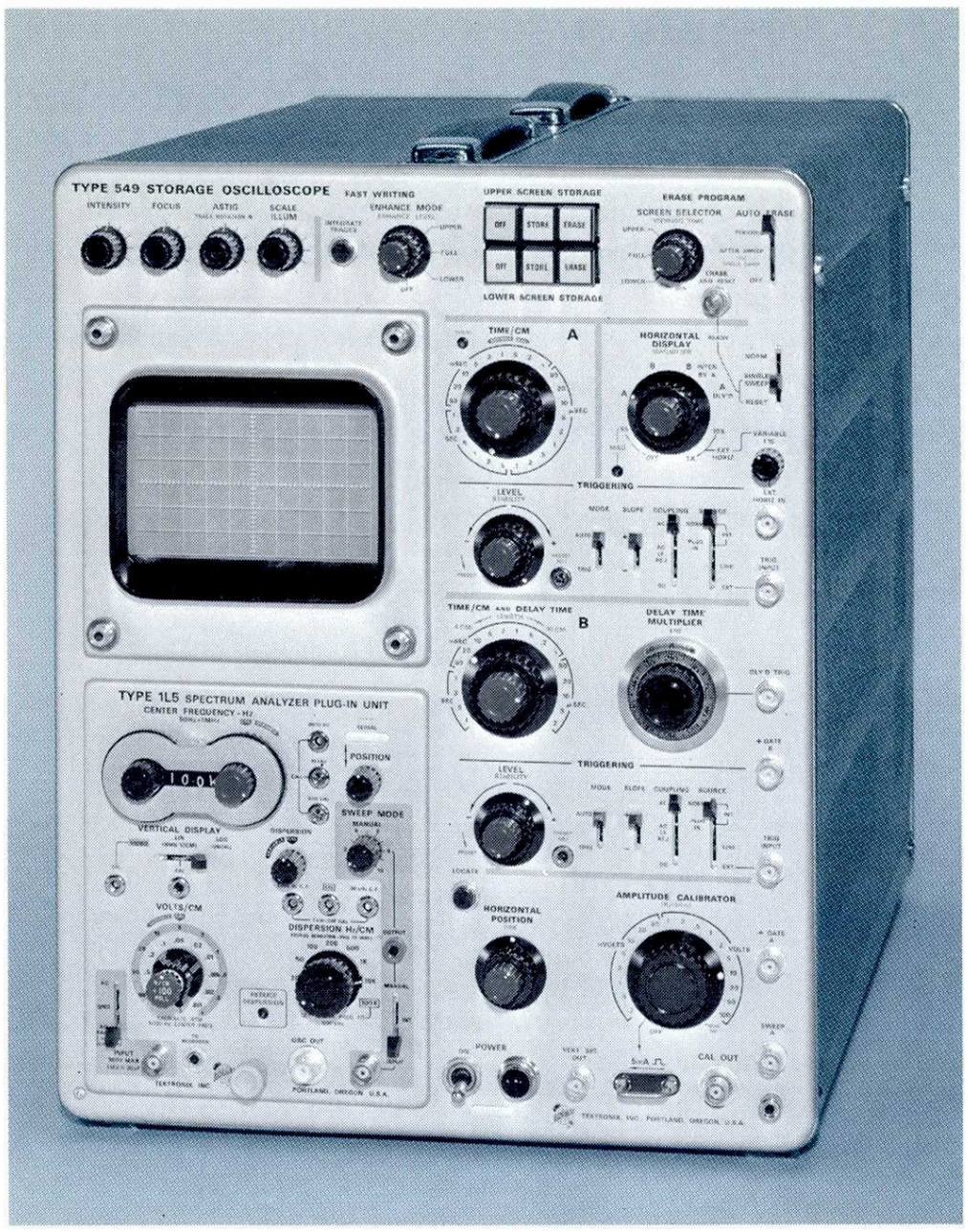
OPTIONAL ACCESSORIES

Optional accessories expand measurement capabilities and provide added operating convenience. Camera, Probes, Scope-Mobile® Carts and other major accessories are completely described in the catalog accessory pages. Some of the accessories commonly used with this instrument are described in the Reference Section for this series.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Split-Screen Storage Oscilloscope

549



- ***BISTABLE SPLIT-SCREEN STORAGE AND CONVENTIONAL DISPLAYS***
- ***VIEW TIME TO ONE HOUR***
- ***BISTABLE STORAGE PROVIDES CONSTANT TRACE INTENSITY FOR FULL VIEW TIME***
- ***ERASES AFTER A SELECTABLE VIEW TIME AND STORES NEW INFORMATION, AUTOMATICALLY***
- ***CALIBRATED SWEEP DELAY***
- ***FULL-BANDWIDTH TRIGGERING***
- ***ACCEPTS MULTI-TRACE, DIFFERENTIAL, SAMPLING, SPECTRUM ANALYZER AND SPECIAL PURPOSE PLUG-INS***

CHARACTERISTIC SUMMARY

VERTICAL

Vertical deflection characteristics extremely flexible through use of all Letter-Series and 1-Series Plug-In Units.

HORIZONTAL

CALIBRATED TIME BASE—0.1 μs/cm to 5 s/cm.
X5 MAGNIFIER—Extends time base to 20 ns/cm.
CALIBRATED SWEEP DELAY—2 μs to 10 s.
EXTERNAL INPUT—0.2 V/cm, DC to 350 kHz.

STORAGE CRT

DISPLAY AREA—6 x 10 cm.
SPLIT SCREEN STORAGE—Store on either upper or lower half of screen with non-storage on other half; store on entire screen; or non-store on entire screen.
LOCATE ZONE—Locate button permits vertical position finding.
VIEWING TIME—Up to one hour.
ERASE TIME—150 ms maximum.
WRITING SPEED—0.5 cm/μs. 5 cm/μs with enhancement.
PHOSPHOR—P1

OTHER

AMPLITUDE CALIBRATOR—0.2 mV to 100 V; 5-mA current loop; 1 kHz.
POWER REQUIREMENTS—90 to 136 VAC or 180 to 272 VAC, 50 to 60 Hz, 575 watts.

The Type 549 extends the exclusive Tektronix split-screen and bistable storage features into research and development applications. Offering a high degree of versatility, it accepts all letter-series and 1-series plug-in units covering many applications including sampling and spectrum analysis.

The split-screen, bistable CRT provides high contrast displays and unparalleled writing speeds. Each half of the 6 x 10-cm display area can be independently controlled, thus allowing stored or conventional displays on either the upper or lower half. A stored display can then be compared simultaneously with a conventional display.

A variable-viewing-time system offers a new convenience to storage oscilloscope users. Through front panel controls, this system can be directed to automatically erase either or both halves of the display area after a predetermined viewing time. Viewing time can be varied from $\leq$0.5 seconds to $\geq$5 seconds with AUTO ERASE selected for either PERIODIC or AFTER-SWEEP operation. Used in conjunction with the SINGLE SWEEP, the "After-Sweep" erase circuit automatically resets the Single-Sweep circuit at the end of the viewing-time interval.

Split-Screen Storage Oscilloscope

549

AVAILABLE DISPLAYS

With the wide range of vertical plug-in units, several types of stored and conventional displays are obtainable. The Type 549, by virtue of a bistable split-screen storage CRT capable of unparalleled writing speeds, extends storage-measuring capability into previously unattainable areas.

SINGLE-TRACE AND MULTI-TRACE

Multi-trace displays are obtained by selecting a Type 1A1, 1A2, 1A4, CA, or M Amplifier Plug-In Unit. All other 1-Series and Letter-Series Plug-In Units will give single-trace displays. Selection of the Type 1A5, 1A6, 1A7A, or G gives differential amplifier operation, while strain gage and other transducer operations are available with the Type Q Unit.

SAMPLING

Sampling displays with risetimes in the sub-nanosecond region are obtained using a Type 1S1 or 1S2 Sampling Unit. The Type 1S1 is a general-purpose sampler with 1 GHz bandwidth, delay line and internal triggering. The Type 1S2 is designed specifically for TDR (time-domain reflectometry) applications, but offers general-purpose sampling with 3.9 GHz bandwidth and built-in triggering.

SPECTRUM ANALYSIS

Spectral displays are obtained using a Type 1L5, 1L10, 1L20, or 1L40 Spectrum Analyzer Plug-In Unit to cover a frequency range from 10 Hz to 40 GHz.

There are decided advantages in using the storage oscilloscope for spectrum analysis. When slow sweep times are used, it is often difficult to view a complete display; however, by storing the display it can be completely and easily observed.

Signal drift is easily measured using the storage technique. The signal is stored and then as subsequent displays are stored, drift of the signal can be observed. Or, the spectral display can be stored on one half of the screen and simply compared with a similar non-stored display on the other.

STORAGE CRT AND DISPLAY FEATURES

STORAGE CRT

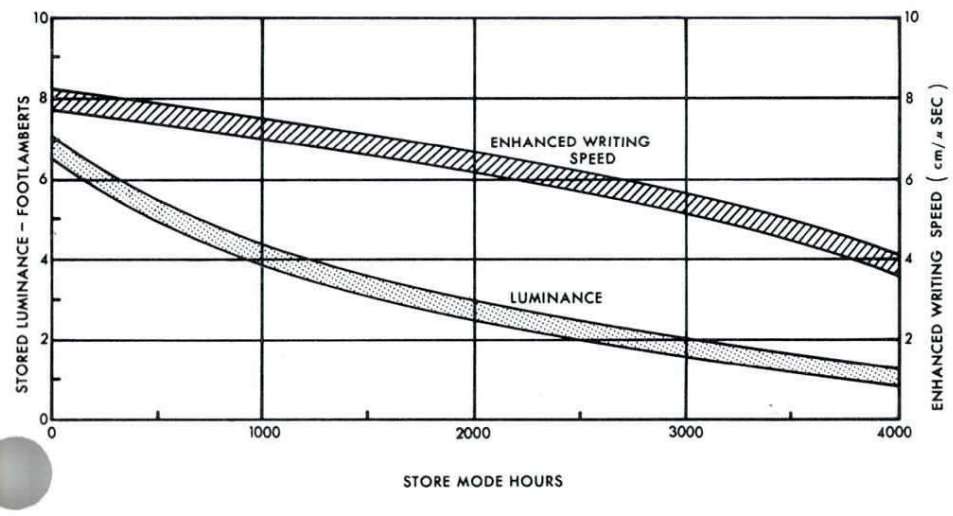
The Type 549 CRT is a split-screen, bistable storage device operated at 4-kV accelerating potential. Phosphor type is P1 (no options).

Tektronix bistable storage offers stored trace brightness independent of viewing time or writing speed.

DISPLAY AREA

6 x 10-cm split-screen storage area with independent or common control, plus locate zone. The graticule is external and edge-lighted.

AGING TRENDS



The aging rate of the storage target depends upon the mode of use. The above chart shows typical brightness and enhanced writing-speed aging characteristics when the target is used continuously in the STORE mode.

SPLIT-SCREEN STORAGE

Store on either upper or lower half of screen with conventional display on other half; store on entire screen; or, non-store on entire screen. Independent operation of both halves.

VIEWING TIME

Up to one hour. If ENHANCE MODE is to be used, it is recommended that displays be stored for 20 minutes or less.

ENHANCE MODE

Controls the single sweep storage capabilities of the storage CRT. Through adjustment of ENHANCE LEVEL control, single-trace spot velocities up to 5 cm/μs or better can be stored with minimal loss of resolution and contrast.

LOCATE BUTTON (Serves two functions)

STORAGE—When depressed, the beam appears at the left of the CRT screen marking the vertical position of the next sweep. CONVENTIONAL DISPLAYS—Permits beam finding of off screen signals.

ERASE TIME

150 ms maximum.

AUTO ERASE SYSTEM

Viewing time before erase continuously variable from $\leq$0.5 s to $\geq$5 s.

In the PERIODIC Mode, there is a continuous sequence of storing, viewing time and erasure. This sequence occurs regardless of whether or not a signal is present and is independent of the sweep. In the AFTER SWEEP mode—which is used in conjunction with the SINGLE SWEEP—the sequence begins with the arrival of the signal. The signal initiates a sweep by triggering the Single Sweep circuitry. Viewing time begins as the sweep ends. At the end of the viewing time, erasure automatically resets the SINGLE SWEEP, readying it for the next signal. This cycle will automatically repeat itself as long as a signal is available.

Manual control available through Erase and Reset button or by Reset position of Single Sweep switch.

REMOTE CONTROL OPERATION

The Type 549 has remote control-operation capabilities using contact closure. A 9-pin connector, located on the rear panel, supplies one ground and 7 inputs (plus one spare) that allows the following functions:

1. Remote erase of upper screen.
2. Remote erase of lower screen.
3. Remote resetting of sweep for single-sweep operation.
4. Remote erase of both halves of the screen and resetting of the sweep.
5. Remote switching from conventional operation to storage operation (independently or commonly) of upper or lower screen halves.
6. Remote interruption of the Auto Erase sequence in order to hold a stored waveform.

Operation of these circuits is achieved by grounding the appropriate pin in the connector.

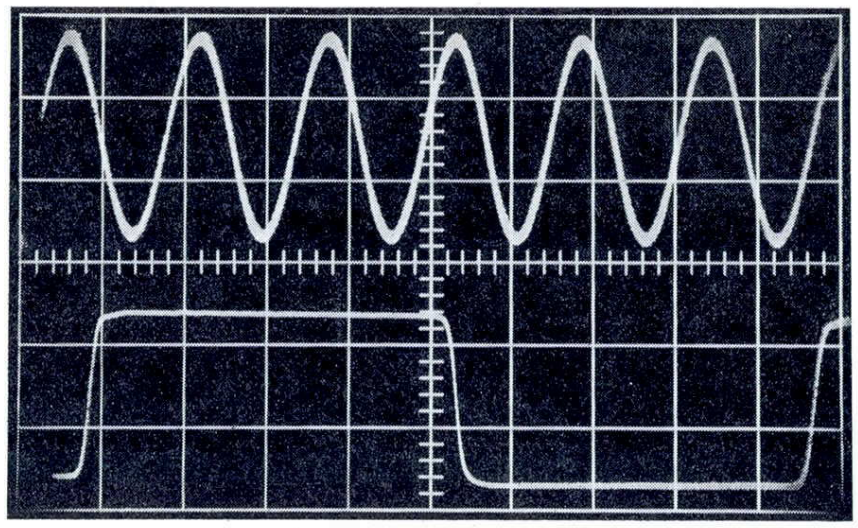
REMOTE CONTROL UNIT

(Optional accessory, part number 012-0102-00). Performs Remote Erase and Reset functions numbers 1, 2, and 3 above.

Z-AXIS INPUT

A CRT grid selector switch on the rear panel allows the CRT grid to be driven from the internal unblanking signal, or from an external source. Bandpass is DC to $\geq$1 MHz at —3 dB. 20 V peak to peak required for beam modulation. Input RC is 100 kΩ and 80 pF. A CRT CATHODE-SELECTOR switch allows the cathode to be driven from the internal chopped-blanking signal, or from an external source, AC coupled. 20 V peak to peak required for beam modulation at normal intensity.

STORED DISPLAYS

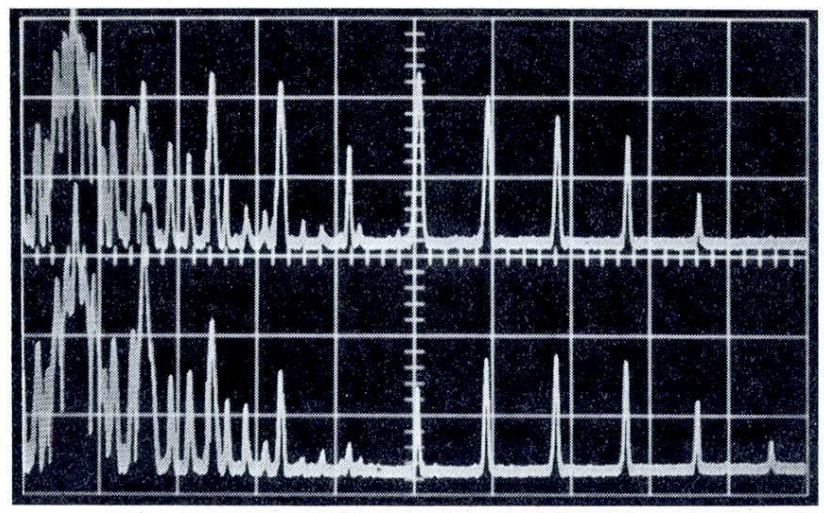


5-cm/μs SINGLE-SWEEP WRITING SPEED

Upper display shows a single shot 625-kHz sinewave stored in enhanced mode of operation. Sweep time is 1 μs/cm.

FAST REPETITIVE DISPLAY

Lower display is a recurrent, 1-MHz squarewave with a risetime of 20 ns stored without enhancement. Sweep time is 0.1 μs/cm.



FREQUENCY-BASED DISPLAY

Harmonic analysis of simulated 440-Hz oboe tone (upper) and violin (lower screen). Dispersion is 500 Hz/cm; minimum resolution bandwidth. Zero-frequency feedthrough is displayed in the first centimeter.

VERTICAL DEFLECTION

BANDWIDTH
DC to ≥30 MHz at 3-dB down, depending on plug-in unit.

RISETIME
≤12 ns, depending on plug-in unit.

DELAY LINE
Permits viewing leading edge of displayed waveform.

SIGNAL OUTPUT
DC to ≥5 MHz at 3-dB down, ≤70-ns risetime, 1.5 V ±20% for each centimeter of displayed signal.

HORIZONTAL DEFLECTION

TIME BASE A
0.1 μs/cm to 5 s/cm in 24 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 12.5 s/cm. Warning light indicates uncalibrated setting.

TIME BASE B
2 μs/cm to 1 s/cm in 18 calibrated steps (1-2-5 sequence), accurate within 3%. Sweep length variable from 4 to 10 cm, allowing use of Time Base B as a repetition-rate generator from 0.1 Hz to 40 kHz.

X5 MAGNIFIER
Operates over full time base, increases fastest Time Base A rate to 20 ns/cm, and the fastest Time Base B rate to 0.4 μs/cm. Magnified time base accurate within 5%.

DELAY TIME
2 μs to 10 s, continuously variable and calibrated, accurate within 1% of indicated delay ±2 minor divisions. Add processing time of 200 ns at fast sweep rates. Incremental delay-time accurate within 1% ±4 minor divisions. Short-term jitter ≤1 part in 20,000 of the available delay time.

DELAY MODES
Depending on the setting of the Delayed Sweep stability control, the Delayed Sweep can start immediately at end of delay time, or be triggerable at end of delay time (for jitter-free displays).

OPERATING MODES
Time Base A, Time Base B, B intensified by A, and A delayed by B. Single sweep in any mode; reset accomplished with ERASE and RESET button on front panel, NORMAL-SINGLE SWEEP-RESET switch on front panel, automatically with AUTO ERASE switch in AFTER SWEEP and NORMAL-SINGLE SWEEP-RESET switch in SINGLE SWEEP, or by remote control through rear-panel connector.

EXTERNAL INPUT
Fixed steps of approx 0.2 V/cm and 2 V/cm, continuously variable between steps and to approx 20 V/cm, DC to ≥350 kHz at —3 dB with maximum gain. 600-V maximum input (DC + peak AC). Input RC approx 1 MΩ paralleled by <60 pF.

SIGNAL OUTPUTS
Gates from both time bases (0 to at least +20 V), sawtooth from Time Base A (0 to at least +130 V), and a delayed trigger pulse (at least +5 V).

TRIGGER

MODES
Automatic or manual level selection. Automatic operation is useful between approx 50 Hz and 1 MHz, minimizes trigger adjustments for signals of different amplitudes, shapes, and repetition rates. With no input (or input less than 50 Hz), automatic triggering occurs at an approx 50-Hz rate, providing a convenient reference trace.

COUPLING
AC, DC, or AC LF reject.

SOURCES
Internal from oscilloscope vertical amplifier (or direct from a single channel of Type 1A1, 1A2 or 1A4 Plug-In Units), external, or line. 50-V maximum external input (DC + peak AC).

TIME BASE A REQUIREMENTS
0.2-cm deflection or 0.3 V external from DC to 10 MHz, increasing to 2-cm deflection or 3 V external at 30 MHz. Requirements increase below 300 Hz with AC coupling, below 200 kHz with AC low-frequency reject. Automatic operation requires 0.2-cm deflection or 0.3 V external from 300 Hz to 10 kHz, increasing to 2-cm deflection or 3 V external at 1 MHz.

TIME BASE B REQUIREMENTS
0.2-cm deflection or 0.3 V external from DC to 1 MHz, increasing to 1-cm deflection or 1.5 V external at 10 MHz. Requirements increase below 300 Hz with AC coupling, below 200 kHz with AC low-frequency reject. Automatic operation requires 0.2-cm deflection or 0.3 V external from 300 Hz to 10 kHz, increasing to 2-cm deflection or 3 V external at 1 MHz.

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR
0.2-mV to 100-V squarewave, 18 calibrated steps (1-2-5 sequence), accurate within 2%. 50-Ω ±2% source resistance from 0.2 mV to 0.2 V. ≈1-μs risetime; 1-kHz ±25% repetition rate; 40% to 60% duty cycle. 100-V DC reference output also provided. Front-panel current loop for 5-mA ±2%, squarewave or DC.

POWER REQUIREMENTS
90 to 136 VAC or 180 to 272 VAC, 50 to 60 Hz; 575 watts maximum at 115 V and 60 Hz. Rear panel selector provides rapid accommodation for six line-voltage ranges.

DIMENSIONS AND WEIGHTS

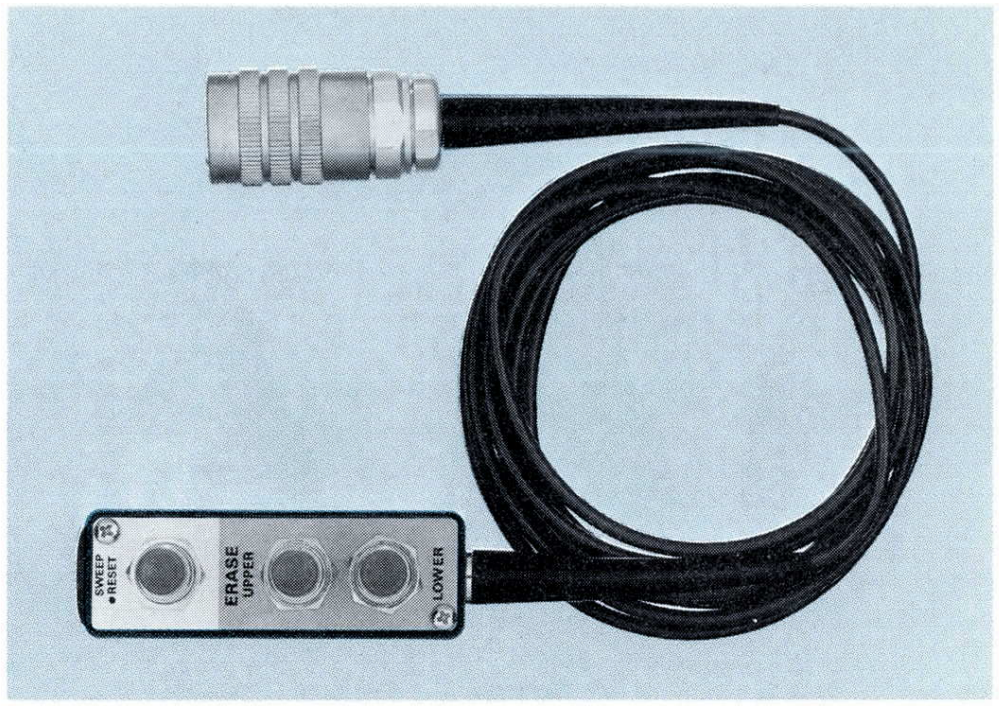
Height	17 in	43.2 cm
Width	$12\frac{15}{16}$ in	32.9 cm
Depth	$23\frac{7}{8}$ in	60.7 cm
Net weight	$67\frac{3}{4}$ lb	30.8 kg
Domestic shipping weight	≈ 89 lb	≈40.5 kg
Export-packed weight	≈114 lb	≈51.8 kg

INCLUDED STANDARD ACCESSORIES
Two P6006 10X probes (010-0127-00); two BNC-to-BNC 18-inch patch cords (012-0087-00); BNC-to-binding post adapter (103-0033-00); 3 to 2-wire adapter (103-0013-00); smoke-gray light filter (378-0567-00); two instruction manuals (070-0508-00).

TYPE 549 OSCILLOSCOPE, without plug-in units . . **$2625**

OPTIONAL ACCESSORIES

Optional accessories expand measurement capabilities and provide added operating convenience. Camera, Probes, Scope-Mobile® Carts and other major accessories are completely described in the catalog accessory pages. Some of the accessories commonly used with this instrument are described in the Reference Section for this series.



REMOTE-CONTROL UNIT
Separate controls for erase of upper screen, erase of lower screen, and single-sweep reset. Mates to oscilloscope rear-panel connector, 9-foot cable, order 012-0102-00 $33.00

REMOTE-CONTROL CONNECTOR
9-pin cable connector for 5 erase and reset functions plus selection of storage or non-storage operation. Mates to oscilloscope rear-panel connector. Cable and control unit not included, order 134-0049-00 . . . . . $4.70

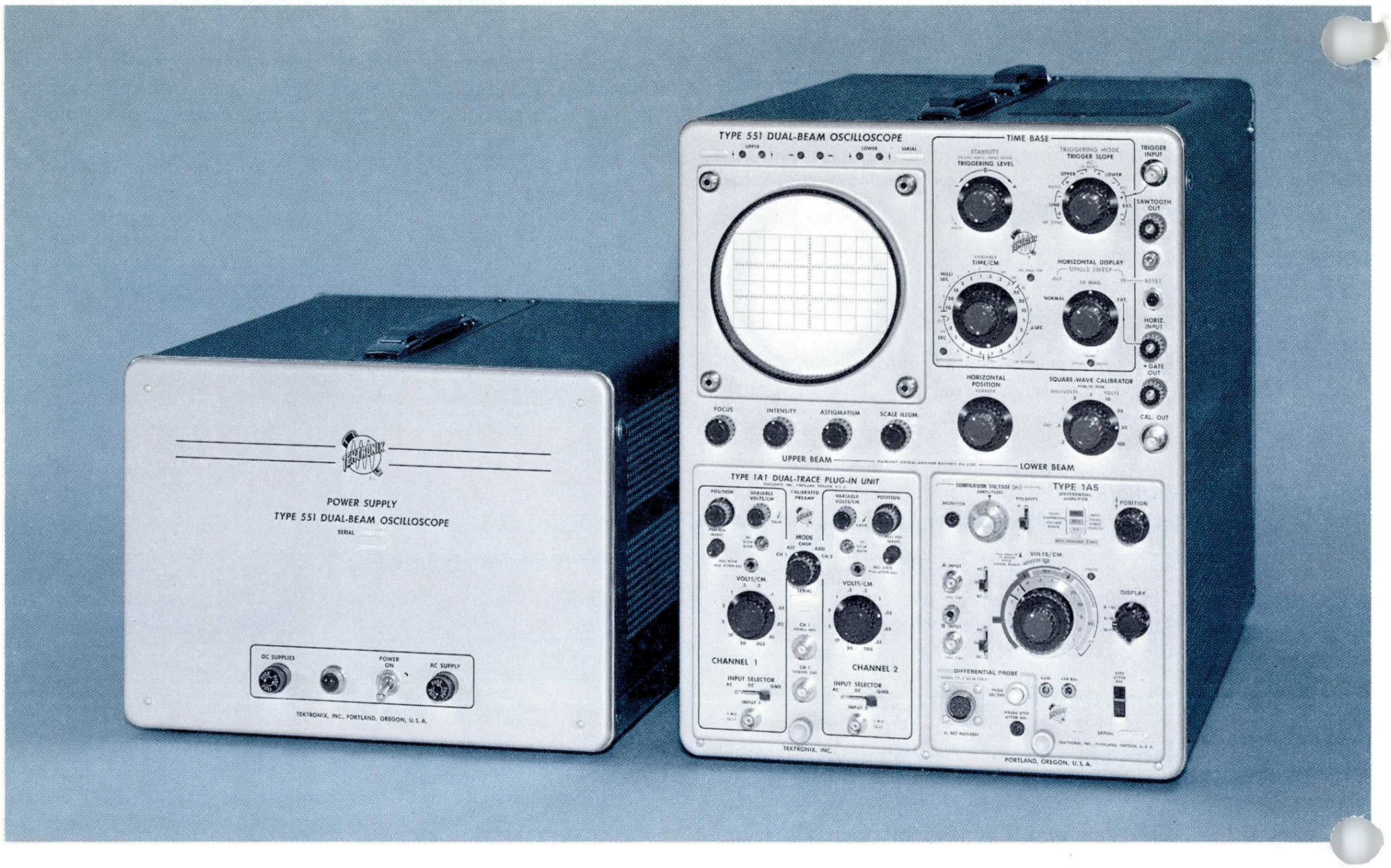
RACKMOUNT ADAPTER
Consists of cradle to support the Type 549 in any standard 19-in relay rack, and mask to fit around the front panel. Requires $17\frac{1}{2}$-inch panel height, order 040-0281-00 . . $34.50

U.S. Sales Prices FOB Beaverton, Oregon

Please refer to Terms and Shipment, General Information page.

27-MHz Dual-Beam Oscilloscope

551



CHARACTERISTIC SUMMARY

VERTICAL

2 identical vertical-deflection systems.

Letter-Series and 1-Series Plug-in Units offer a wide selection of vertical-deflection characteristics for both beams.

HORIZONTAL

CALIBRATED TIME BASE—0.1 μs/cm to 5 s/cm.

5X MAGNIFIER—Extends time base to 20 ns/cm.

EXTERNAL INPUT—0.2 V to 50 V/cm; DC to 400 kHz.

CRT

DISPLAY AREA—4 x 10 cm (each beam), 2-cm overlap.

ACCELERATING VOLTAGE—10 kV.

PHOSPHOR—P31.

OTHER

AMPLITUDE CALIBRATOR—0.2 mV to 100 V, 1-kHz square-wave.

POWER REQUIREMENTS—105 V to 125 V or 210 V to 250 V, 900 watts maximum.

- ***TWO VERTICAL-DEFLECTION SYSTEMS***
- ***COMMON HORIZONTAL DEFLECTION***
- ***4 x 10-cm DISPLAY PER BEAM***
- ***ACCEPTS MULTI-TRACE, DIFFERENTIAL, SAMPLING, AND SPECTRUM ANALYZER PLUG-IN UNITS***

The Type 551 uses a Tektronix two-gun cathode-ray tube with two pairs of vertical-deflection plates. A single pair of horizontal-deflection plates is common to both electron beams. The two wide-band main amplifiers in the Type 551 are designed for Tektronix Letter-Series and 1-Series Plug-In Units, providing a high degree of signal-handling versatility in both channels. Both electron beams are simultaneously deflected horizontally at any one of many sweep rates provided by an accurately-calibrated time base generator.

VERTICAL DEFLECTION

2 identical systems

BANDWIDTH
DC to 27 MHz at 3-dB down, depending on plug-in unit.

RISETIME
13 ns, depending on plug-in unit.

DELAY LINE
Permits viewing leading edge of displayed waveform.

HORIZONTAL DEFLECTION

Common to both beams

TIME BASE

0.1 μs/cm to 5 s/cm in 24 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 12 s/cm. Warning light indicates uncalibrated setting.

X5 MAGNIFIER

Operates over full time base, increases fastest rate to 20 ns/cm. Magnified time base accurate within 5%.

OPERATING MODES

Normal, single sweep.

EXTERNAL INPUT

Continuously variable from 0.2 V/cm to 50 V/cm, DC to ≥400 kHz at —3 dB. 50-V maximum input (DC + peak AC) in most sensitive position. Input RC approx 100 kΩ paralleled by approx 30 pF.

SIGNAL OUTPUTS

Gate (positive going from 0 to at least +20 V), sawtooth (positive going from 0 to at least +150 V). Cathode follower outputs.

TRIGGER

MODES

Automatic or manual level selection; high-frequency sync. Automatic operation is useful between approx 50 Hz and 2 MHz, minimizes trigger adjustments for signals of different amplitudes, shapes, and repetition rates. With no input (or input less than 40 Hz), automatic triggering occurs at an approx 50-Hz rate, providing a convenient reference trace. High-frequency sync assures a steady display of sinewaves from approx 5 MHz to 30 MHz.

COUPLING

AC, DC, or AC LF reject.

SOURCES

Internal (from either oscilloscope vertical amplifier), external, or line. External trigger input RC approx 1 MΩ paralleled by approx 55 pF.

REQUIREMENTS

0.2-cm deflection or 0.2 V external from DC to below 5 MHz, increasing to 1-cm deflection or 1 V external at 5 MHz. Requirements increase below 16 Hz with AC coupling, below 16 kHz with AC low-frequency reject. Automatic operation requires 0.4-cm deflection or 0.4 V external from 60 Hz to 250 kHz, increasing to 1-cm deflection or 1 V external at 2 MHz. High-frequency sync requires 2-cm deflection or 2 V external from approx 5 Hz to 30 MHz.

CRT

TEKTRONIX DUAL-BEAM CRT

4 x 10-cm display per beam with at least 2-cm overlap. Separate vertical-deflection plates; common horizontal deflection plates. Metallized screen, helical post accelerating anode. 10-kV accelerating potential for bright displays. P31 phosphor normally supplied; P1, P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. Z-axis input is AC coupled to CRT cathode, requires 20 V peak to peak for beam modulation at normal intensity.

GRATICULE

External; variable edge lighting. 6 x 10-cm display area. Vertical and horizontal center lines marked in 2-mm divisions.

DISPLAY FEATURES

Beam-position indicators show direction of each CRT beam when off screen.

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR

0.2 mV to 100 V squarewave, 18 calibrated steps (1-2-5 sequence), accurate within 3%, approx 1-kHz repetition rate.

POWER REQUIREMENTS

Wired for 105 to 125 VAC (117 V nominal); transformer taps permit operation at 107, 117, 127, 214, 234 or 254 VAC: 50 to 60 Hz. 850-W maximum power consumption. Can be factory wired for any of the above nominal voltages, if so indicated on order.

OSCILLOSCOPE DIMENSIONS AND WEIGHTS

Height	17 in	43.2 cm
Width	12 15/16 in	32.9 cm
Depth	23 7/8 in	60.7 cm
Net weight	51 3/4 lb	23.5 kg
Domestic shipping weight	≈71 lb	≈32.3 kg
Export-packed weight	≈92 lb	≈41.8 kg

POWER SUPPLY DIMENSIONS AND WEIGHTS

Height	10 9/16 in	26.8 cm
Width	13 5/16 in	33.8 cm
Depth	17 7/16 in	44.3 cm
Net weight	43 1/2 lb	19.8 kg
Domestic shipping weight	≈52 lb	≈23.6 kg
Export-packed weight	≈71 lb	≈32.3 kg

INCLUDED STANDARD ACCESSORIES

Four P6006 10X probes (010-0127-00); two BNC-to-BNC 18-inch patch cords (012-0087-00); BNC-to-banana plug 18-inch patch cord (012-0091-00); BNC-post jack (012-0092-00); 3 to 2-wire adapter (103-0013-00); 3-conductor power cord (161-0010-03); inter-unit cable (012-0032-01); smoke-gray light filter (378-0567-00); two instruction manuals (070-0245-00).

TYPE 551 OSCILLOSCOPE, without plug-in units . . **$2200**

OPTIONAL ACCESSORIES

INTER-UNIT CABLE

Six-foot cable allows increased separation of Type 551 and Power Supply, order 012-0051-00 ..... $33

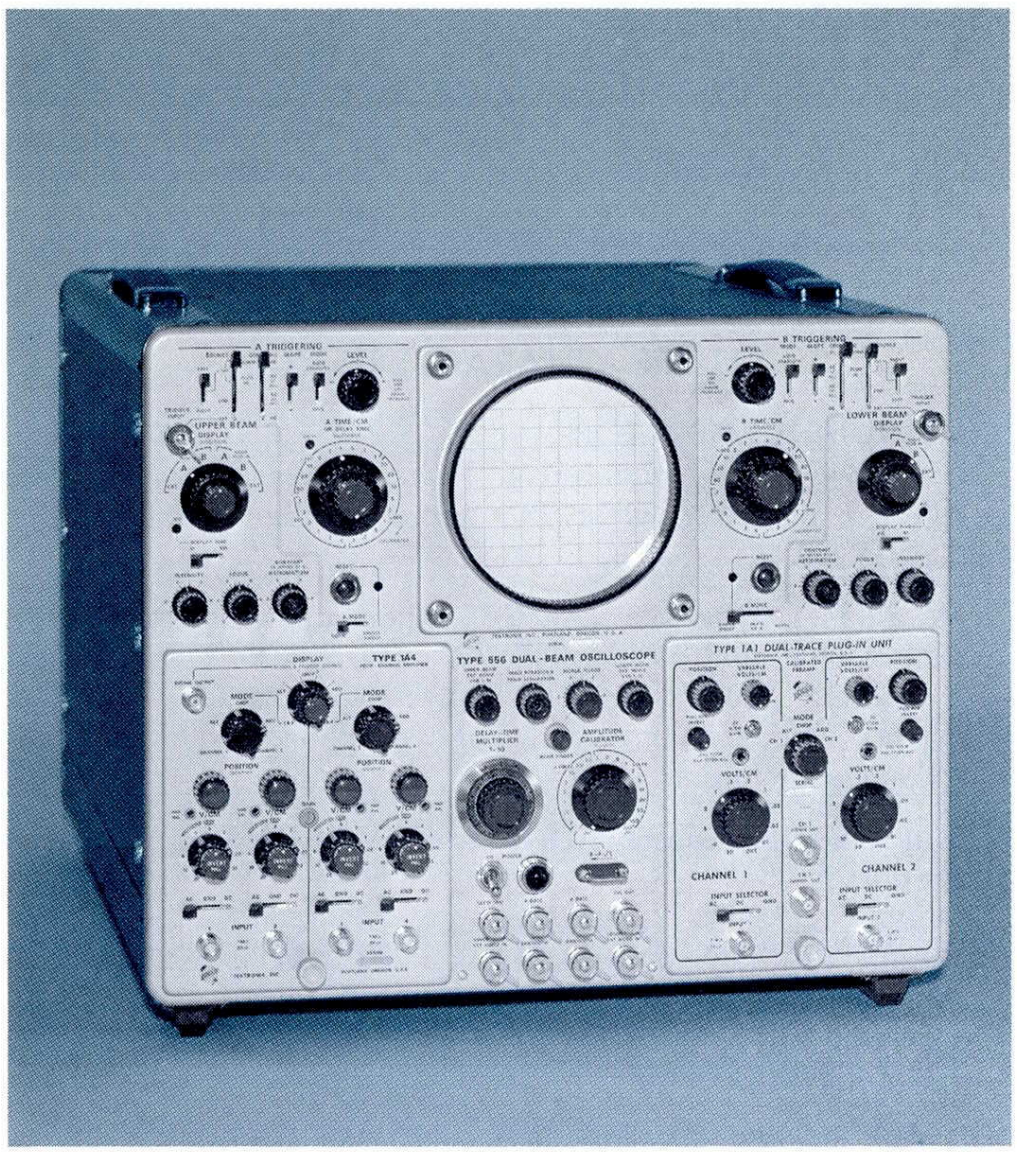
RACKMOUNT ADAPTER

Consists of two cradles to support the Type 551 and Power Supply in any standard 19-inch relay rack, and two masks to fit around the front panels. Requires 17 1/2-inch panel height for Type 551, 12 1/4-inch panel height for Power Supply. Order 040-0279-00 ..... $83

Optional accessories expand measurement capabilities and provide added operating convenience. Cameras, Probes, Scope-Mobile® Carts and other major accessories are completely described in the catalog accessory pages. Some of the accessories commonly used with this instrument are described in the reference section for this series.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

556 50-MHz Dual-Beam Oscilloscope RM556



- *TWO VERTICAL AND HORIZONTAL SYSTEMS*
- *OVER 50 DISPLAY MODES INCLUDING DUAL-BEAM DISPLAY WITH ONE INPUT*
- *CALIBRATED SWEEP DELAY*
- *EMI SUPPRESSION*
- *6 x 10-cm DISPLAY PER BEAM*
- *ILLUMINATED PARALLAX-FREE GRATICULE*
- *FULL-BANDWIDTH TRIGGERING*
- *ACCEPTS MULTI-TRACE, DIFFERENTIAL, SAMPLING, AND SPECTRUM ANALYZER PLUG-IN UNITS*

The Type 556 and R556 are dual-beam laboratory instruments for accurate measurement in the DC to 50 MHz range. Features include independent vertical and horizontal deflection systems, trigger selectability for cross triggering, and uniform-focus CRT with 6 x 10-cm scan per beam.

Unique display capability allows simultaneous display of one signal at two different sweep times, using only one probe for minimum circuit loading.

CHARACTERISTIC SUMMARY

VERTICAL

2 identical vertical-deflection systems

Letter-Series and 1-Series Plug-In Units offer wide selection of vertical-deflection characteristics for both beams.

HORIZONTAL

2 independent horizontal-deflection systems

CALIBRATED TIME BASE—0.1 μs/cm to 5 s/cm.
X10 MAGNIFIER—Extends time base to 10 ns/cm.
CALIBRATED SWEEP DELAY—0.1 μs to 50 s.
EXTERNAL INPUT—$\leq$0.1 V/cm to approx 10 V/cm; DC to $\geq$400 kHz.

CRT

DISPLAY AREA—6 x 10 cm per beam, 4-cm overlap.
ACCELERATING VOLTAGE—10 kV.
PHOSPHOR—P31

OTHER

ELECTROMAGNETIC INTERFERENCE—Meets MIL-I-6181D, Radiated: 150 kHz to 1 GHz; Conducted: 150 kHz to 25 MHz.
AMPLITUDE CALIBRATOR—1-kHz squarewave; 0.2 mV to 100 V; 100 VDC; 5 mA, 1-kHz squarewave; 5 mA DC.
POWER REQUIREMENTS—90 VAC to 136 VAC, 180 VAC to 272 VAC; 50 to 60 Hz; $\approx$840 watts, 1 kVA (maximums).

VERTICAL DEFLECTION

2 identical systems

BANDWIDTH
DC to $\geq$50 MHz at 3-dB down, depending on plug-in unit.

RISETIME
$\leq$7 ns, depending on plug-in unit.

DELAY LINE
Permits viewing leading edge of displayed waveform.

HORIZONTAL DEFLECTION

2 identical systems

TIME BASE A AND B
0.1 μs/cm to 5 s/cm in 24 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 12.5 s/cm. Warning light indicates uncalibrated setting.

X10 MAGNIFIER
Operates over full time base, increases fastest rate to 10 ns/cm. Magnified time base accurate within 5%.

DELAYED SWEEP MODE
Delayed sweep starts after time interval determined by DELAY TIME and DELAY TIME MULTIPLIER. DELAY TIME CONTROL selects 0.1 μs to 5 s delay time in a 1, 2, 5 sequence. Accurate within 1%. DELAY TIME MULTIPLIER provides continuously calibrated time intervals from 0.20 to 10.00 times the DELAY TIME. Dial divided into 1,000 parts. Accuracy within 0.2% of full scale from 1 μs to 5 s and within 0.5% of full scale from 0.1 μs to 0.5 μs. Inherent delay to start of delayed sweep 150 ns or less.

DIFFERENTIAL TIME MEASUREMENT ACCURACY
Within 1% and 4 minor divisions from 1 μs to 5 s and within 1% and 10 minor divisions from 0.1 μs to 0.5 μs. Jitter <1 part in 20,000 of 10 times DELAY TIME.

DELAY RANGE
1 μs to 50 s after start of delaying sweep.

DELAY MODES

Delayed sweep starts immediately at end of delay time, or is triggerable at end of delay time (for jitter-free displays).

OPERATING MODES

Time Base A—Normal and Single Sweep.
Time Base B—Normal, B delayed by A, and Single Sweep.

EXTERNAL INPUT

≤0.1 V/cm with X10 Display Mag, ≤1 V/cm with X1 Display Mag, continuously variable from ≤0.1 V/cm to approx 10 V/cm. DC to ≥400 kHz at 3-dB down. 50 V maximum (DC + peak AC). Input RC approx 1 megohm paralleled by ≈65 pF.

SIGNAL OUTPUTS

Gates from both time bases (≥+10 V), sawtooths from both time bases (≥9 V/cm), delayed trigger pulse (≥7 V).

TRIGGER

(2 identical systems)

MODES

Triggered and Auto Stability. Latter mode free runs sweep in absence of triggering signal, triggers on signals ≥30 Hz.

COUPLING

AC, DC, AC LF reject, AC HF reject.

SOURCES

Internal from left or right vertical amplifier, left or right plug-in, external, or line. External trigger input RC approx 1 megohm paralleled by approx 35 pF. 50-V maximum external input (DC + peak AC). External trigger signals that have an amplitude greater than 2 V and a rate of rise exceeding 1/3 V/ns may cause erratic triggering. Internal source selectable from the oscilloscope vertical amplifier, or direct from a single channel of Type 1A1, 1A2, and 1A4 Plug-In Units. The latter mode displays the true time relationship between signals when plug-ins are in chopped or alternate operation.

REQUIREMENTS

AC INTERNAL—0.2-cm, 60 Hz to 10 MHz; 1 cm at 50 MHz.

AC EXTERNAL—0.2 V, 60 Hz to 10 MHz; 0.4 V at 50 MHz.

AC LF REJECT—INT or EXT requirement increases below 2.5 kHz.

AC HF REJECT—INT or EXT requirement increases above 60 kHz (≥2-cm deflection or ≥2 V at 2 MHz).

DC INTERNAL—0.35-cm, DC-to-10 MHz; 2 cm at 50 MHz.

DC EXTERNAL—0.2 V, DC-to-10 MHz; 0.4 V at 50 MHz.

DISPLAY LOGIC

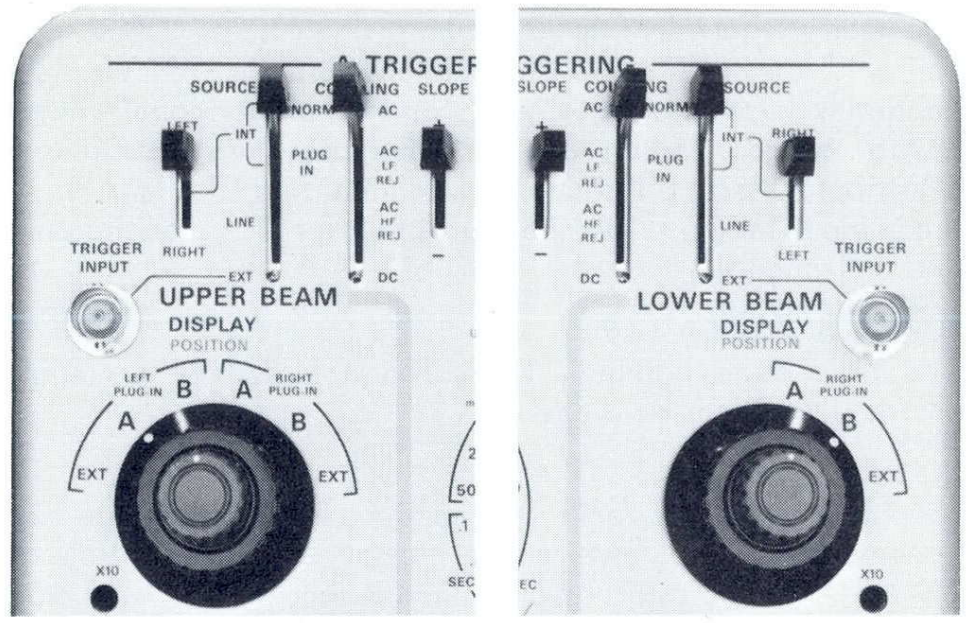
A dual-beam oscilloscope, with two horizontal and vertical deflection systems, presents the ability to select the driving source to the deflection systems . . . thereby greatly increasing the versatility.

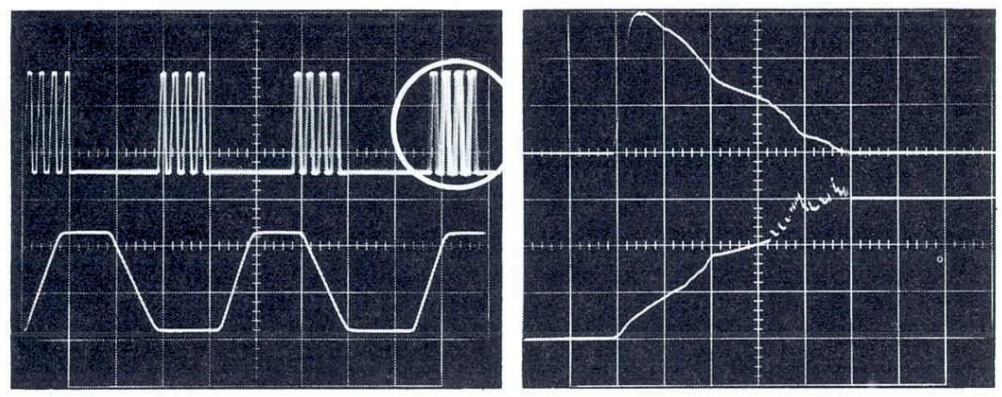
The Time Base generators can be switched to either UPPER-BEAM horizontal or LOWER-BEAM horizontal to give independent or identical time-based displays, or simultaneous display of one time base delayed accurately by the other.

The signal under test has the potential to be channeled from the plug-ins to either vertical amplifier. In the Type 556, the RIGHT plug-in unit output can be directed to either the UPPER-BEAM vertical or the LOWER-BEAM vertical or both. This means, among other things, only one probe need be attached to the signal source to perform delaying sweep operations. This reduces the loading effect on sensitive circuitry. The LEFT plug-in unit can be coupled to the UPPER-BEAM vertical only.

The triggering signal source to each Time Base trigger circuit can be selected from either UPPER-BEAM or LOWER-BEAM vertical (NORM), RIGHT or LEFT plug-in unit (necessary only in 1-series multi-trace plug-ins), or EXTERNAL.

Following are presentations of the front-panel controls which program display logic, and descriptions (with waveforms) of a few of many display combinations.



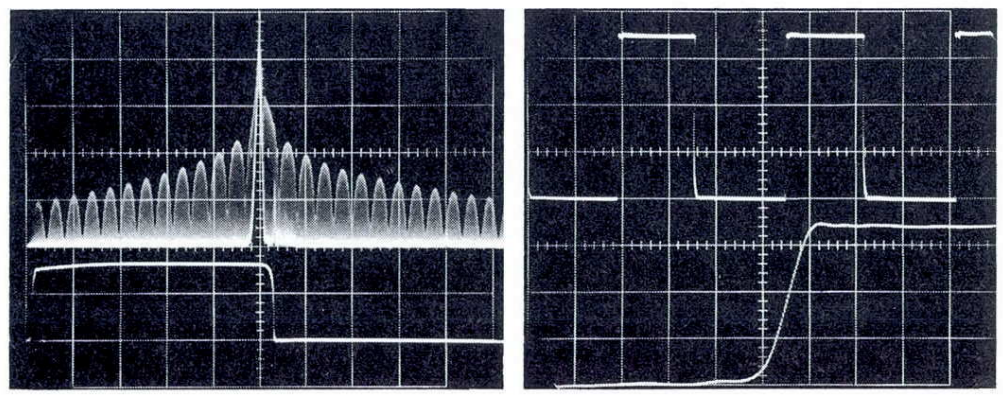


SINGLE-INPUT DUAL-BEAM DISPLAY (Above left)

Upper beam shows bursts of 2.5-MHz pulses on Time Base A with time variation between bursts. This shows up as increasing time-jitter between the first and successive bursts. The lower beam shows Time Base B (0.1 μs/cm) delayed by Time Base A and triggered on the second pulse of the last burst to provide a jitter-free expanded display of the A Sweep intensified zone. The use of only one probe and one plug-in input simplifies signal connection and provides minimum loading on the signal source.

SIMULTANEOUS SINGLE-SHOT DISPLAYS (Above right)

Current versus voltage display of a 0.75 ampere, fast-blow fuse during destructive overload. Both beams are driven by B Time Base (50 μs/cm) which is delayed by pre-triggered A Time Base to provide base reference lines before and after the event. The upper beam shows the current through the fuse at 30 A/cm while the lower beam shows the corresponding voltage across the fuse at 100 V/cm.



TIME AND FREQUENCY DISPLAYS (Above left)

Upper beam shows the spectral output of a 200-MHz gated oscillator applied as IF feedthrough to a Type 1L20 Spectrum Analyzer; the calibrated dispersion is 1 MHz/cm. The lower beam shows a real-time display of the 10-kHz gating pulse (0.5 μs/cm).

SAMPLING AND REAL-TIME DISPLAYS (Above right)

Upper beam shows a squarewave at 1 μs/cm, as applied to a Type 1A2 Plug-In. The lower beam shows the leading-edge of the same waveform at 1 ns/cm, as applied to a Type 1S1 Wide-Band Sampling Plug-In.

556 50-MHz Dual-Beam Oscilloscope RM556

CRT AND DISPLAY FEATURES

TEKTRONIX DUAL-BEAM CRT

5-inch round tube, 8 x 10-cm display area; ≥6 x 10 cm per beam with 4-cm overlap. Spot size, focus uniformity and geometry equivalent to our finest single-beam tubes. Aluminized construction, helical post acceleration. P31 phosphor normally supplied; P1, P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. Z-axis input requires 10 V peak to peak for CRT modulation at normal intensity.

INTERNAL GRATICULE

Variable edge lighting. Vertical and horizontal centerlines marked in 2-mm divisions.

DISPLAY CONTROLS

Separate intensity, focus and astigmatism controls for each beam, upper and lower beam intensity contrast controls between A sweep and non-intensified-B-zone of A sweep, trace rotation (screwdriver adjustment), and trace separation. BEAM FINDER button functions in both X-Y systems, indicates direction of off-screen signals.

OTHER CHARACTERISTICS

ELECTROMAGNETIC INTERFERENCE

Oscilloscopes meet interference specifications of MIL-I-6181 D over the following frequency ranges: Radiated (with CRT mesh filter and BNC connector covers installed) —150 kHz to 1 GHz; conducted (power line) —150 kHz to 25 MHz.

AMPLITUDE CALIBRATOR

0.2 mV to 100 V in 18 calibrated steps (1-2-5 sequence), accuracy within ±2%. 50-Ω source resistance from 0.2 mV to 0.2 V. ≤1.5-μs risetime; 1-kHz ±25% repetition rate; 45% to 55% duty cycle. 100-V DC reference output also provided. Front-panel current loop for 5-mA ±2%, squarewave or DC.

POWER REQUIREMENTS

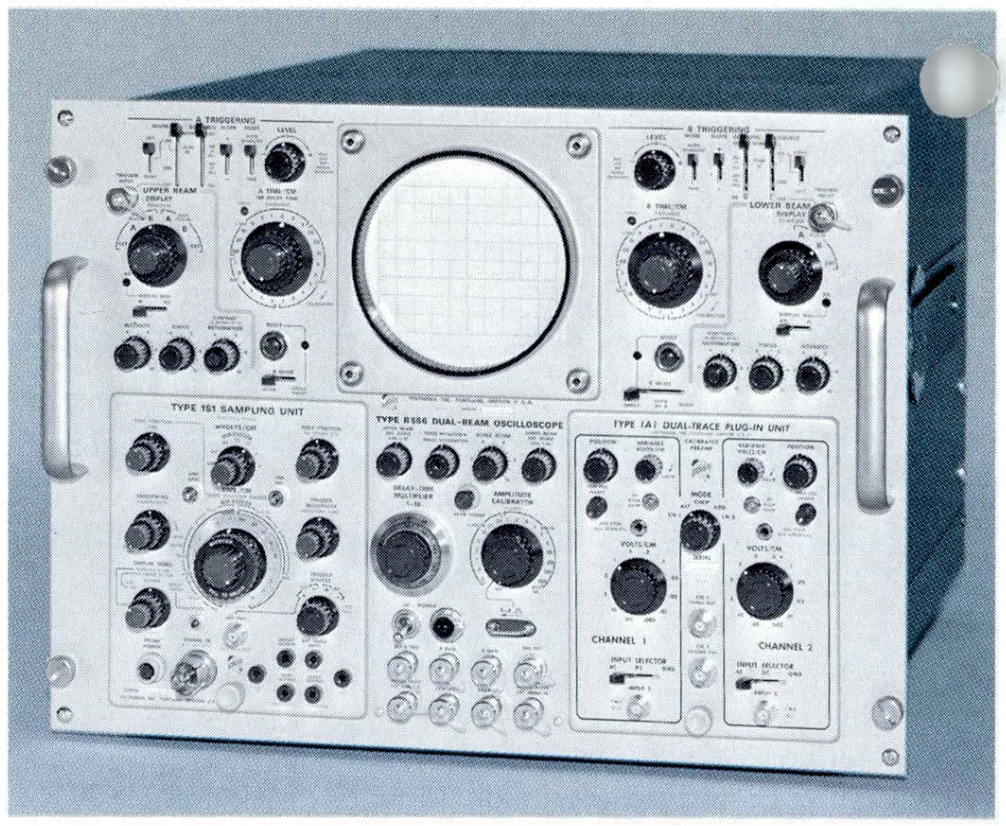
90 to 136 VAC or 180 to 272 VAC, 50 to 60 Hz source with less than 2% harmonic distortion; approx 840 W maximum, approx 1 kVA maximum. Rear-panel selector provides rapid accommodation for six line-voltage ranges.

CABINET MODEL DIMENSIONS AND WEIGHTS

Height	$15\frac{3}{16}$ in	38.6 cm
Width	$16\frac{15}{16}$ in	43.0 cm
Depth	24 in	61.0 cm
Net weight	83 lb	37.7 kg
Domestic shipping weight	≈135 lb	≈61.5 kg
Export-packed weight	≈148 lb	≈67.3 kg

RACK MODEL DIMENSIONS AND WEIGHTS

Height	14 in	35.6 cm
Width	19 in	48.3 cm
Rack depth	$22\frac{13}{16}$ in	57.9 cm
Net weight	$87\frac{3}{4}$ lb	39.9 kg
Domestic shipping weight	≈151 lb	≈68.6 kg
Export-packed weight	≈162 lb	≈73.6 kg



RACKMOUNTING

Type R556 mounts on tilting slide-out tracks to standard 19-inch rack. Further mounting information on catalog instrument dimension page.

INCLUDED STANDARD ACCESSORIES

Four P6008 10X probes (010-0129-00); eighteen BNC caps, ten installed (016-0088-00); 3 to 2-wire adapter (103-0013-00); 3-conductor power cord (161-0030-01); smoke-gray light filter (378-0567-00); clear CRT protector plate (387-0918-00); graticule cover (200-0382-00); CRT mesh filter, installed (378-0572-00); two instruction manuals (070-0757-00). Type R556 includes mounting tracks (351-0086-00) and mounting hardware; two instruction manuals (070-0758-00).

TYPE 556 OSCILLOSCOPE, without plug-in units . . **$3700**
TYPE R556 OSCILLOSCOPE, without plug-in units . **$3800**

OPTIONAL ACCESSORIES

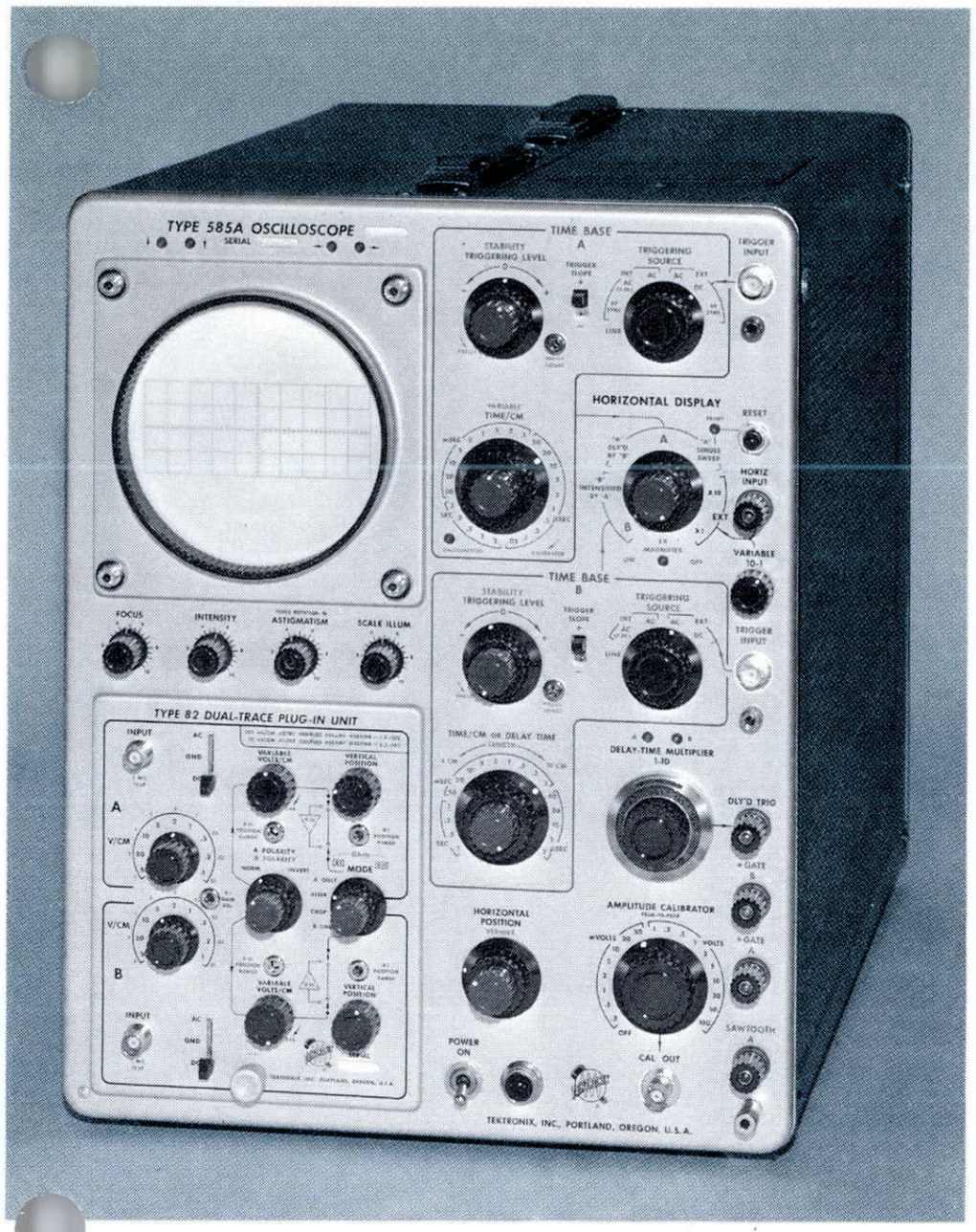
Optional accessories expand measurement capabilities and provide added operating convenience. Camera, Probes, Scope-Mobile® Carts and other major accessories are completely described in the catalog accessory pages. Some of the accessories commonly used with this instrument are described in the Reference Section for this series.

SCOPE-MOBILE® CART

Model 205-2: storage drawer, carrier for 3 plug-in units, 9-position tilt-lock oscilloscope tray, order 205-2 . . . . . $160

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

585A 80-MHz Oscilloscope RM585A



- ***CALIBRATED SWEEP DELAY***
- ***TUNNEL DIODE TRIGGERING TO BEYOND 150 MHz***
- ***ILLUMINATED PARALLAX-FREE GRATICULE***
- ***SINGLE SWEEP***
- ***SINGLE-TRACE AND DUAL-TRACE VERTICAL PLUG-IN UNITS***
- ***MORE THAN 20 OTHER VERTICAL PLUG-IN UNITS (with adapter)***

CHARACTERISTIC SUMMARY

VERTICAL

Dual-Trace DC to 80 MHz (approx 3-dB down) displays at 100 mV/cm or DC to 75 MHz (approx 3-dB down) displays at 10 mV/cm are available with the Type 82 Dual-Trace Plug-In Unit. Extreme flexibility of vertical deflection characteristics through the use of a wide variety of plug-in units.

HORIZONTAL

CALIBRATED TIME BASE—Time Base A: 50 ns/cm to 2 s/cm; Time Base B: 2 μs/cm to 1 s/cm.

SWEEP MAGNIFIER—X5, extends Time Base A to 10 ns/cm.

CALIBRATED SWEEP DELAY—2 μs to 10 s, continuously variable.

EXTERNAL INPUT—0.2 V/cm to 15 V/cm; DC to 350 kHz at maximum gain.

CRT

DISPLAY AREA—4 x 10 cm.

ACCELERATING VOLTAGE—10 kV.

PHOSPHOR—P31.

OTHER

AMPLITUDE CALIBRATOR—0.2 mV to 100 V, 1-kHz square-wave.

POWER REQUIREMENT—105 to 125 V or 210 to 250 V, 50 to 60 Hz, 630 watts maximum.

Type 585A and Type RM585A are general-purpose laboratory instruments. Features are designed to permit signal analysis from DC to 80 MHz (3-dB down) and beyond. Tunnel Diode triggering from DC to 150 MHz, 10-ns/cm sweep speed, and calibrated sweep delay complement the response characteristic of the Type 82 Dual-Trace Plug-In Unit or Type 86 Single-Trace Plug-In Unit. The Type 81A Adapter permits use of any letter series or 1-series plug-in units: adding Sampling, Spectrum Analysis, and High Gain Differential measurement capability.

80-MHz Oscilloscope

VERTICAL DEFLECTION

BANDWIDTH AND RISETIME

Bandwidth figures are at 3-dB down.

TYPE 82 PLUG-IN UNIT	MINIMUM BANDWIDTH	MAXIMUM RISETIME
at 100 mV/cm	80 MHz	4.4 ns
at 10 mV/cm	75 MHz	4.7 ns

BALANCED DELAY NETWORK

Permits observation of the leading edge of the waveform that triggers the sweep.

HORIZONTAL DEFLECTION

TIME BASE A

50 ns/cm to 2 s/cm in 24 calibrated steps (1-2-5 sequence), accurate within 3%. Continuously variable (uncalibrated) between steps and to approximately 5 s/cm. Warning light indicates uncalibrated setting.

TIME BASE B

2 μs/cm to 1 s/cm in 18 calibrated steps (1-2-5 sequence), accurate within 3%. Control for varying sweep length from 4 to 10 cm permits Time Base B to be used as a repetition-rate generator from 0.1 Hz to 40 kHz.

X5 MAGNIFIER

Operates over full time base, increases the fastest Time Base A rate to 10 ns/cm and fastest Time Base B rate to 0.4 μs/cm. Magnified time base accurate within 5%.

DELAYED SWEEP MODE

Delayed sweep starts after time interval determined by DELAY TIME and DELAY TIME MULTIPLIER. DELAY TIME CONTROL selects 2 μs to 1 s delay time in a 1, 2, 5 sequence accurate to within 1% from 2 μs to 0.1 s and within 3% from 0.2 s to 1 s. DELAY TIME MULTIPLIER provides continuously calibrated time intervals from 0.20 to 10.00 times the DELAY TIME. Accurate within 0.2% of full scale.

DIFFERENTIAL TIME MEASUREMENT ACCURACY

Within 1% and 4 minor divisions from 2 μs to 0.1 s and within 3% and 4 minor divisions from 0.2 s to 1 s. Jitter $\leq$1 part in 20,000 of 10 times DELAY TIME.

DELAY RANGE

2 μs to 10 s after start of delaying sweep.

OPERATING MODES

Time Base A: Normal, single sweep, delayed by B.
Time Base B: Normal, intensified by A.

EXTERNAL INPUT

Continuously variable deflection factor from 0.2 V/cm to 15 V/cm. DC to 350 kHz at maximum gain. Input RC approx 1 megohm paralleled by approx 47 pF.

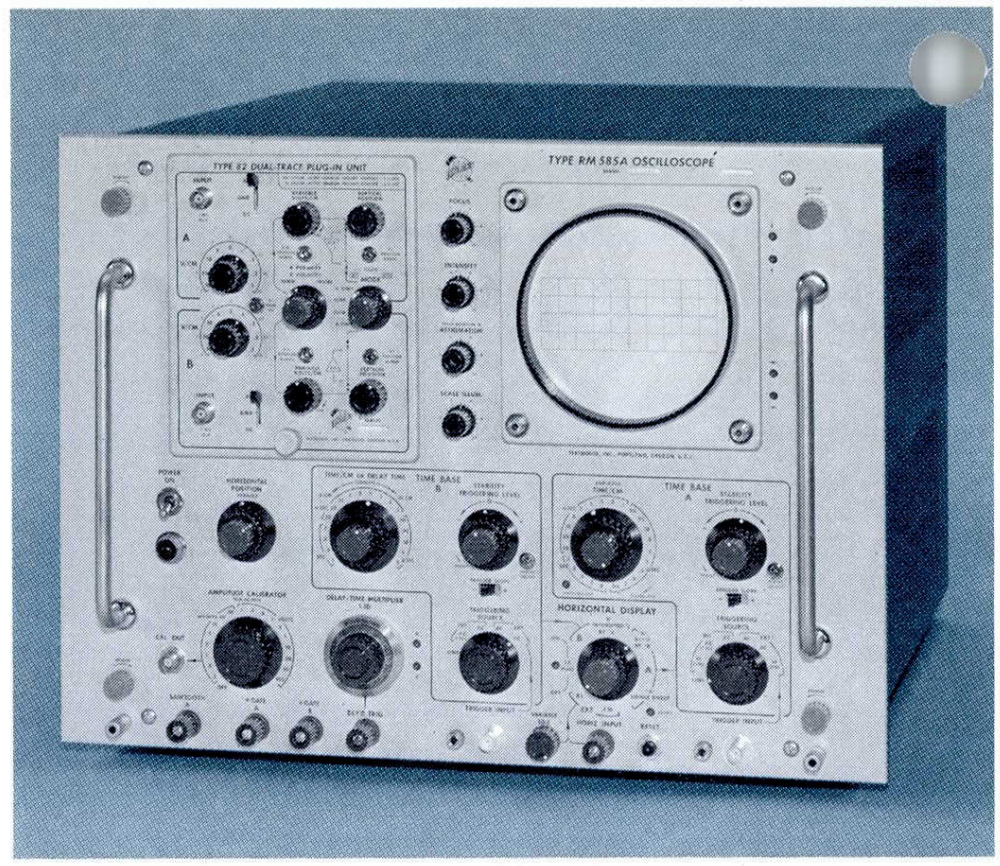
SIGNAL OUTPUTS

Positive gates from both time bases of approx 20 V, a positive-going sawtooth of approx 150 V and a delayed trigger pulse of approx +5 V.

CRT

TEKTRONIX CRT

5-in CRT metalized, accelerating potential 10 kV. P31 phosphor normally supplied; P2, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. Z-axis input requires 20 V peak to peak for beam modulation at normal intensity.



GRATICULE

Parallax-free, 4 x 10 cm, internal graticule with variable edge illumination is ruled in 1-cm divisions with vertical and horizontal centerlines further marked in 2-mm increments.

DISPLAY FEATURES

Beam-position indicators light to show direction of CRT beam when it is off the screen.

TRIGGER

SOURCES

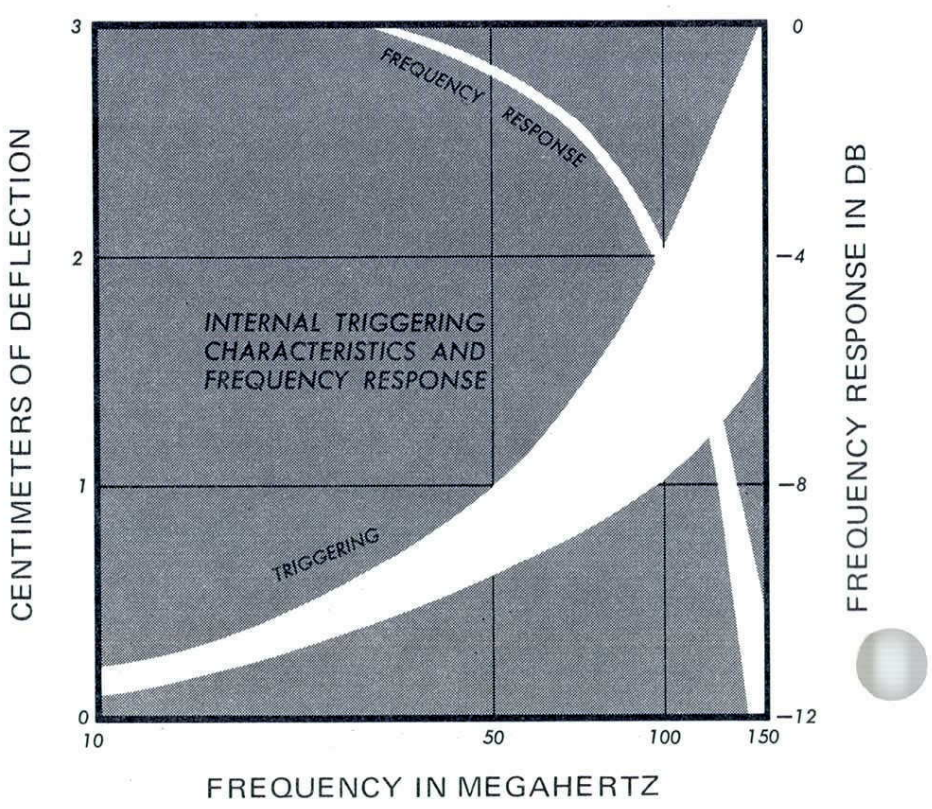
Internal, external, or line. Internal sources are AC coupled. External sources are AC or DC coupled. External trigger input RC approx 1 megohm paralleled by approx 30 pF.

TIME BASE A REQUIREMENTS

2-mm deflection or 0.3 V external from 15 Hz to 5 MHz. Requirements increase below 15 Hz with AC coupling, below 15 kHz with AC LF Reject. HF Sync requires 4-mm deflection or 0.2 V external from 5 MHz to 250 MHz.

TIME BASE B REQUIREMENTS

4-mm deflection or 0.5 V external from 15 Hz to 1 MHz, increasing to 2-cm deflection or 1.5 V external at 5 MHz. Requirements increase below 15 Hz with AC coupling, below 15 kHz with AC LF Reject.



OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR

0.2 mV to 100-V squarewave in 18 steps (1-2-5 sequence). Accurate within 3%. Approx 1-kHz repetition rate.

POWER OPTIONS

Wired for 105 to 125-V operation, 50 to 60 Hz. Tapped transformer allows operation at 210 to 250 V. Power consumption 630 watts maximum.

TYPE 585A DIMENSIONS AND WEIGHTS

Height	16⅞ in	42.9 cm
Width	13⅞ in	33.4 cm
Depth	23⅞ in	58.2 cm
Net weight	67¼ lb	30.6 kg
Domestic shipping weight	≈ 85 lb	≈38.6 kg
Export-packed weight	≈104 lb	≈47.3 kg

TYPE RM585A DIMENSIONS AND WEIGHTS

Height	14 in	35.6 cm
Width	19 in	48.3 cm
Depth	22¾ in	57.8 cm
Net weight	83½ lb	38.0 kg
Domestic shipping weight	≈108 lb	≈49.1 kg
Export-packed weight	≈131 lb	≈59.5 kg

INCLUDED STANDARD ACCESSORIES

3 to 2-wire adapter (103-0013-00); 3-conductor power cord (161-0010-03); smoke-gray filter, installed (378-0567-00); clear CRT-protector plate (387-0918-00); 18-inch BNC-to-BNC patch cord (012-0087-00); 18-inch BNC-to-banana-plug patch cord (012-0091-00); BNC post jack (012-0092-00); Type 585A—two instruction manuals (070-0391-01). Type RM585A—two instruction manuals (070-0392-00); set mounting hardware included with Type RM585A.

TYPE 585A OSCILLOSCOPE, without plug-in units . **$2000**
TYPE RM585A OSCILLOSCOPE, without plug-in units **$2100**

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience. See catalog accessory pages for additional information on these and other items.

C27-662 R CAMERA

Equipped with a special lens to permit single-sweep photography of Type 585A Oscilloscope displays at fast writing speeds. 1:0.5, f/1.3 lens; Polaroid Land* Roll-Film Back.
Order C-27-662 R $635
Bezel Mounting Adapter Assembly, order 016-0225-02 .. $ 16

PROBES

The standard 10X probes supplied with Type 82 plug-in unit satisfy most measurement requirements; however, optional probes (recommended on plug-in unit pages) may be better suited for particular applications.

SCOPE-MOBILE® CART

Model 202-2: storage drawer, carrier for 2 plug-in units, 9-position tilt-lock oscilloscope tray.
Order Type 202-2 ..... $155

*Registered Trademark, Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information Page

Plug-In Adapter

81A

The Type 81A Adapter allows use of all 1-Series and Letter-Series Plug-In Units with 580-Series Oscilloscopes. The full bandwidth capabilities of the plug-in units are realized. For example, the Type 1A5 Differential Amplifier provides DC-to-50 MHz displays at 5 mV/cm.

No cabling or switching is required; the Type 81A is simply inserted into the oscilloscope, then the plug-in unit is inserted into the adapter. Provision for chopped blanking when used with a multi-trace plug-in is not available.

WEIGHTS

Net weight	4 lb	1.8 kg
Domestic shipping weight	≈ 6 lb	≈3 kg
Export-packed weight	≈11 lb	≈5 kg

INCLUDED STANDARD ACCESSORIES

Instruction manual (070-0751-00).

TYPE 81A PLUG-IN ADAPTER $175

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

EXTEND CAPABILITIES OF TYPE 580-SERIES OSCILLOSCOPES TO THESE AREAS

VERTICAL PLUG-IN UNITS

PLUG-IN UNIT	MINIMUM DEFLECTION FACTOR	BANDWIDTH (—3 dB)	T_R	PRICE
MULTIPLE TRACE				
1A1 Dual-Trace	50 mV/cm 5 mV/cm ≈500 μV/cm	DC to 50 MHz DC to 28 MHz 2 Hz to 15 MHz	7 ns 13 ns 24 ns	$ 650
1A2 Dual-Trace	50 mV/cm	DC to 50 MHz	7 ns	360
1A4 Four-Trace	10 mV/cm	DC to 50 MHz	7 ns	895
SINGLE TRACE				
L	50 mV/cm 5 mV/cm	DC to 30 MHz 3 Hz to 24 MHz	12 ns 15 ns	$ 260
SPECIAL PURPOSE				
O Operational	50 mV/cm	DC to 25 MHz	14 ns	$ 625
Q Strain Gage	10 μstrain/div	DC to 6 kHz	60 μs	400

PLUG-IN UNIT	MINIMUM DEFLECTION FACTOR	BANDWIDTH (—3 dB)	T_R	PRICE
DIFFERENTIAL				
1A5 Comparator	5 mV/cm 2 mV/cm 1 mV/cm	DC to 50 MHz DC to 45 MHz DC to 40 MHz	7 ns 8 ns 9 ns	$ 625
1A6	1 mV/cm	DC to 2 MHz	0.18 μs	295
1A7A High-Gain	10 μV/cm	DC to 1 MHz Selectable	350 ns	525
W Comparator	1 mV/cm 50 mV/cm	DC to 8 MHz DC to 23 MHz	44 ns 16 ns	625
SPECTRUM ANALYZERS				
1L5	10 μV/cm	10 Hz to 1 MHz		$1025
1L10	—100 dBm	1 MHz to 36 MHz		1175
1L20	—110 to —90 dBm	10 MHz to 4.2 GHz		1950
1L40	—110 to —70 dBm	1.5 GHz to 40 GHz		2150
WIDE-BAND SAMPLING				
1S1	2 mV/cm	DC to 1 GHz	350 ps	$1400
1S2 TDR	5 mρ/cm	140-ps system risetime		1525
	5 mV/cm	DC to 3.9 GHz	90 ps	

Dual-Trace Amplifier

82

- ***DC to 80 MHz at 100 mV/cm****
- ***DC to 75 MHz at 10 mV/cm****
- ***CHOPPED OR ALTERNATE SWITCHING***

Two identical input channels add dual-trace capability to Tektronix Type 580-Series Oscilloscopes permitting the display of the time difference between two input signals, the response of two circuits to the same pulse, the input and output waveforms of a circuit, and many other dual-trace functions.

BANDWIDTH AND RISETIME

Bandwidth figures are at 3-dB down and apply to calibrated and uncalibrated deflection factors.

WITHOUT PROBE (Source impedance approx 25 ohms)			
DEFLECTION FACTOR	DC-COUPLED BANDWIDTH	AC-COUPLED LOW-FREQUENCY 3-dB POINT	RISETIME
X1 GAIN 100 mV to 50 V/cm	DC to 80 MHz	2 Hz	4.4 ns
X10 GAIN 10 mV to 5 V/cm	DC to 75 MHz	2 Hz	4.7 ns
WITH P6008 10X PROBE			
X1 GAIN 1 V to 500 Vcm	DC to 70 MHz	0.2 Hz	5 ns
X10 GAIN 100 mV to 50 V/cm	DC to 66 MHz	0.2 Hz	5.3 ns

DEFLECTION FACTOR

100 mV/cm to 50 V/cm in 9 calibrated steps (1-2-5 sequence), accurate within 3%. 2:1 variation, uncalibrated, between steps and to approx 100 V/cm.

X10 AMPLIFIER

DC coupled, extends deflection factor to 10 mV/cm. Operates at all deflection-factor settings, accurate within 3%.

P6008 10X PASSIVE PROBES

Increase input resistance to 10 megohms and decrease input capacitance to approx 7 pF. Risetime of Type 580-Series Oscilloscope with Type 82 Plug-In Unit and P6008 Probe, at an overall deflection factor of 1 V/cm is 5 ns.

INPUT RC

1 megohm paralleled by approx 15 pF.

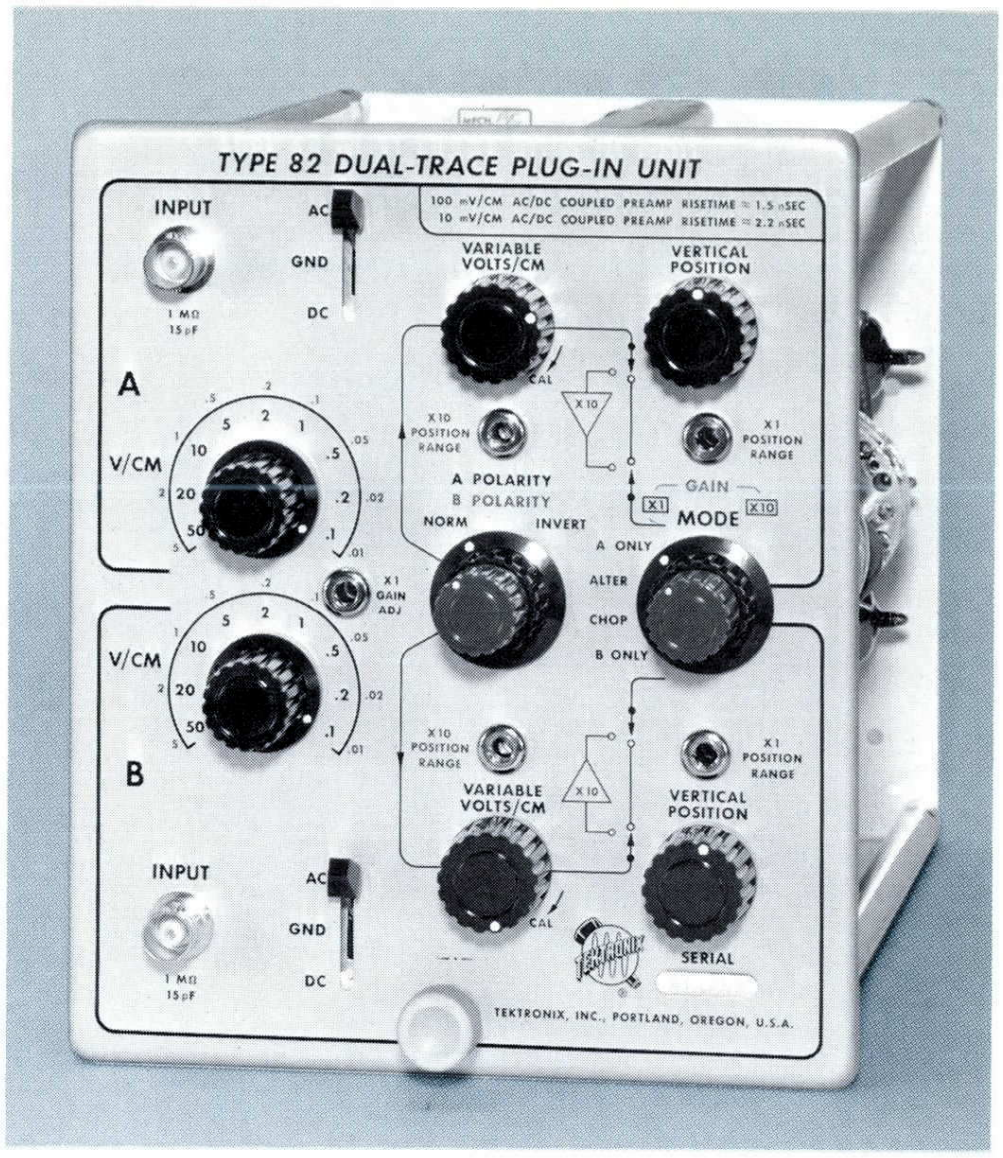
MAXIMUM INPUT VOLTAGE

600 V combined DC + peak AC.

WEIGHTS

Net weight	5 lb	2.3 kg
Domestic shipping weight	≈10 lb	≈4.5 kg
Export-packed weight	≈14 lb	≈6.4 kg

*[illegible]ox 3-dB down



INCLUDED STANDARD ACCESSORIES

Two P6008 probes (010-0129-00); two instruction manuals (070-0349-01).

TYPE 82 DUAL-TRACE PLUG-IN UNIT $765

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience. The standard probe supplied with the instrument satisfies most measurement requirements; optional probes, including high-voltage and current-measuring probes, may be better suited for particular applications. See catalog accessory pages for additional information on these and other items.

PROBES

P6009 100X Passive Probe Package, order 010-0140-00 $66.00
P6011 1X Passive Probe Package, order 010-0193-00 . . $21.00

MODIFICATION FOR EARLY INSTRUMENTS

TYPE 581/585 VERTICAL STANDARDIZATION MOD KIT improves and standardizes the transient response of early Type 580-Series Oscilloscopes. The Mod Kit is essential for the use of Type 82 or Type 86 Plug-In Unit in the early instruments and also improves the performance of these instruments when used with the Type 80/P80 combination.

Tektronix Type 580-Series Oscilloscopes with serial numbers prior to #950 for Type 581 and #2585 for Type 585 may require this modification. Please consult your Field Engineer or Distributor.

Each kit includes components to change delay-line impedance, standardize CRT termination, modify CRT and distributed amplifier circuitry, and modify Type 80/P80 combination.

Order 040-0275-01 . . . . . $27.50

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Dual-Trace Amplifier

1A1

- ***5 mV/cm-to-20 V/cm CALIBRATED DEFLECTION FACTOR***
- ***≈500-μV/cm SINGLE CHANNEL***
- ***CHANNEL 1 SIGNAL & TRIGGER OUTPUTS***
- ***1-MHz CHOPPING RATE***
- ***SOLID-STATE DESIGN, FET INPUTS***

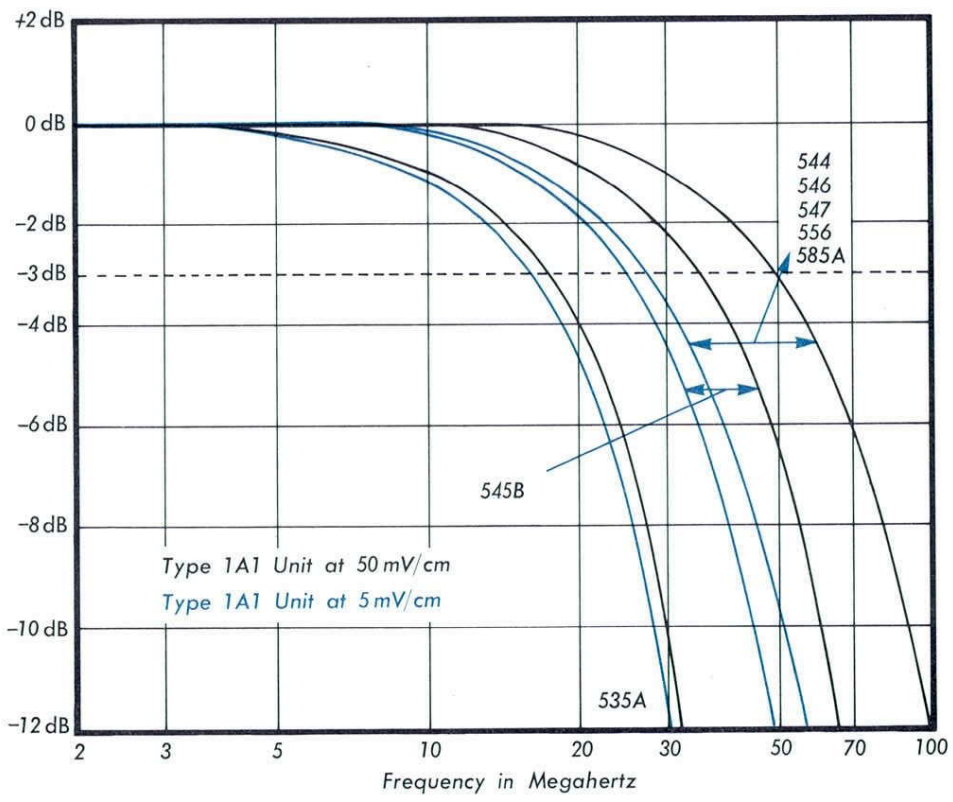
Type 1A1 provides dual-trace displays in Type 530, 540, 550 and 580* Series Oscilloscopes. Maximum bandwidth is achieved in Type 544, 546, 547, 556, and 585A Oscilloscopes. Input channels are identical with separate controls for coupling, attenuating, inverting and positioning the signal.

Used with the Type 547 or RM547 Oscilloscopes, the alternate switching circuit can be slaved to the display switching circuit in the oscillocope, thus locking Channel 1 to Time Base A and Channel 2 to Time Base B. For many applications this provides the equivalent of a dual-beam oscilloscope without the additional complexity and cost.

Solid state components are used throughout except for the output stage.

Type 127, 132, 133 Power Supplies are available to operate the Type 1A1 outside an oscilloscope. See the descriptions of these instruments for details.

TYPICAL BANDWIDTH



TYPE 1A1 UNIT AND OSCILLOSCOPE	DEFLECTION FACTOR	BANDWIDTH† (—3 dB)	RISE-TIME
535A	50 mV/cm 5 mV/cm ≈500 μV/cm	DC to 15 MHz DC to 14 MHz 2 Hz to 10 MHz	24 ns 25 ns 35 ns
545B	50 mV/cm 5 mV/cm ≈500 μV/cm	DC to 33 MHz DC to 23 MHz 2 Hz to 14 MHz	11 ns 16 ns 25 ns
544, 546, 547, 556, 585A*	50 mV/cm 5 mV/cm ≈500 μV/cm	DC to 50 MHz DC to 28 MHz 2 Hz to 15 MHz	7 ns 13 ns 24 ns
549	50 mV/cm 5 mV/cm ≈500 μV/cm	DC to 30 MHz DC to 23 MHz 2 Hz to 14 MHz	12 ns 16 ns 25 ns
551	50 mV/cm 5 mV/cm ≈500 μV/cm	DC to 27 MHz DC to 21 MHz 2 Hz to 13 MHz	13 ns 17 ns 27 ns

*A Type 81A Adapter is required.
†Low-frequency 3-dB point, AC coupled: 2 Hz, 0.2 Hz with 10X probe.

Dual-Trace Amplifier

1A1

DEFLECTION FACTOR

nV/cm to 20 V/cm in 12 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/cm.

INPUT RC

1 megohm paralleled by approx 15 pF.

MAXIMUM INPUT VOLTAGE

600 V combined DC + peak AC.

OPERATING MODES

Either single channel, normal or inverted; algebraic addition; chopped or alternate electronic switching between channels. Alternate: channels switched at the end of each sweep. Chopped: successive 500-ns segments of each channel displayed at an approx 1-MHz rate per channel. Chopped transient blanking except in Type 551, and 585A Oscilloscopes.

SIGNAL OUTPUT

Channel 1 Output provides up to X10 gain, can be AC coupled into Channel 2 for approx 500-μV/cm deflection factor. Noise or frequency filters can be inserted between channels if desired. Output impedance is approx 50 Ω. Maximum bandwidth of output alone is DC to 35 MHz; see chart for bandwidths at 500 μV/cm.

TRIGGER OUTPUT

Channel 1 output for external triggering permits viewing true time relationship between signals in alternate or chopped operation. Output also applied internally to Type 544, 546, 547, 549, and 556 Oscilloscopes. Approx 0.5 V for each centimeter of displayed signal at 1 kHz with calibrated deflection factors.

WEIGHTS

Net weight	6 lb	2.6 kg
Domestic shipping weight	≈11 lb	≈5.0 kg
Export-packed weight	≈14 lb	≈6.4 kg

INCLUDED STANDARD ACCESSORIES

BNC-to-BNC 50-Ω cable (012-0076-00), two instruction manuals (070-0885-00).

TYPE 1A1 PLUG-IN UNIT $650

OPTIONAL ACCESSORIES

The probes recommended for use with this plug-in unit satisfy most measurement requirements. Other probes are available for current and high-voltage measurements. See catalog accessory pages for additional information on these and other items.

P6008** 10X Probe Package, order 010-0129-00 .... $46.50

P6009 100X Probe Package, order 010-0140-00 ..... $66.00

P6028 1X Probe Package, order 010-0074-00 ..... $16.50

**P6008 10X Probes included with Type 544, 546, 547 and 556 Oscilloscopes increase input resistance to 10 MΩ and decrease input capacitance to approx 7.5 pF. Bandwidth of probe and oscilloscope is 45 MHz or greater; risetime is approx 7 ns.

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Dual-Trace Amplifier

1A2

- ***50 mV/cm-to-20 V/cm CALIBRATED DEFLECTION FACTOR***
- ***CHANNEL 1 OR 2 TRIGGER OUTPUT***
- ***220-kHz CHOPPING RATE***

Type 1A2 plug-in unit provides dual-trace displays in 530, 540, 550, and 580* Series Oscilloscopes. Unit has identical input channels with separate controls for coupling, attenuating, inverting and positioning the signal. Chopped or alternate electronic switching is used for dual-trace displays.

When the unit is used with Type 547 or RM547 Oscilloscopes, the alternate switching circuit can be slaved to the display switching circuit in the oscilloscope, thus locking Channel 1 to Time Base A and Channel 2 to Time Base B. For many applications this provides the equivalent of a dual-beam oscilloscope without the additional complexity and cost.

Type 127, 132, and 133 Power Supplies are available to operate the Type 1A2 outside an oscilloscope. See the description of these instruments for details.

TYPE 1A2 UNIT AND OSCILLOSCOPE	BANDWIDTH† (—3 dB)	RISETIME
535A	DC to 15 MHz	24 ns
545B	DC to 33 MHz	11 ns
544, 546, 547, 556, 585A*	DC to 50 MHz	7 ns
549	DC to 30 MHz	12 ns
551	DC to 27 MHz	13 ns

*A Type 81A Adapter is required.
†Low-frequency 3-dB point, AC coupled: 2 Hz, 0.2 Hz with 10X probe.

DEFLECTION FACTOR
50 mV/cm to 20 V/cm in 9 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/cm.

INPUT RC
1 megohm paralleled by approx 15 pF.

MAXIMUM INPUT VOLTAGE
600 V combined DC + peak AC.

OPERATING MODES
Either single channel, normal or inverted; algebraic addition; chopped or alternate electronic switching between channels. Alternate: channels switched at the end of each sweep. Chopped: successive 2-μs segments of each channel displayed at an approx 220-kHz rate per channel. Chopped transient blanking except in Type 551, and 585A Oscilloscopes.

COMMON-MODE REJECTION
$\geq$20:1 throughout full bandwidth for signals up to 0.5 V peak-to-peak (measured at maximum gain).

TRIGGER OUTPUT
Channel 1 or 2 output for external triggering permits viewing true time relationship between signals in alternate or chop operation. Output also applied internally to Type 544, 546, 547, 549, and 556 Oscilloscopes. At least 0.5 V for each centimeter of displayed signal at 1 kHz with calibrated deflection factors.

WEIGHTS

Net weight	4½ lb	2.0 kg
Domestic shipping weight	≈ 8 lb	≈3.6 kg
Export-packed weight	≈14 lb	≈6.4 kg

INCLUDED STANDARD ACCESSORIES
Two instruction manuals (070-0430-01).

TYPE 1A2 PLUG-IN UNIT $360

OPTIONAL ACCESSORIES

The probes recommended for use with this plug-in unit satisfy most measurement requirements. Other probes are available for current and high-voltage measurements. See catalog accessory pages for additional information on these and other items.

P6008** 10X Probe Package, order 010-0129-00 . . . . . $46.50
P6009 100X Probe Package, order 010-0140-00 . . . . . $66.00
P6028 1X Probe Package, order 010-0074-00 . . . . . $16.50

**P6008 10X Probes included with Type 544, 546, 547 and 556 Oscilloscopes increase input resistance to 10 MΩ and decrease input capacitance to approx 7.5 pF. Bandwidth of probe and oscilloscope is 45 MHz or greater; risetime is approx 7 ns.

U. S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information Page.

Four-Trace Amplifier

1A4

- ***10 mV/cm-to-20 V/cm DEFLECTION FACTOR***
- ***FOUR-CHANNEL ADDING (±1±2) + (±3±4)***
- ***SIGNAL OUTPUT***
- ***SOLID-STATE DESIGN, FET INPUTS***

This plug-in unit for Type 530, 540, 550*, and (with adapter) 580-Series Oscilloscopes through versatile switching logic provides the equivalent of two wide-band, dual-trace units connected to a third wide-band, dual-trace unit. Maximum bandwidth of DC to 50 MHz is achieved with Type 544, 546, 547 and 556 Oscilloscopes. The Type 1A4 provides a new standard of multi-channel versatility in all Tektronix Oscilloscopes that accept Letter-Series or 1-Series Plug-In Units.

Unique display logic provides unprecedented display flexibility: any channel can be viewed separately, alternately with any other channel(s), chopped with any other channel(s), added to or subtracted from any other channel(s). Alternate, chopped and added modes can also be used together: for example, Channel 1 added to Channel 2, and the resultant alternated with a chopped display of Channel 3 and 4. Used with Type 547 or RM547 Oscilloscopes, the alternate switching circuit in the plug-in unit can be slaved to the display switching circuit in the oscilloscope. For many applications, this provides the equivalent of a dual-beam oscilloscope, without the added complexity and cost.

The four input channels are identical. Each has separate controls for coupling, attenuating, inverting, positioning, and identifying the signal. Solid-state design, with FET inputs, provides low drift and fast stabilization time.

Type 127, 132, and 133 Power Supplies are available to operate the Type 1A4 outside an oscilloscope. See the description of these instruments for details.

CHARACTERISTICS

TYPE 1A4 UNIT AND OSCILLOSCOPE	BANDWIDTH† (—3 dB)	RISETIME
544, 546, 547, 556, 585A**	DC to 50 MHz	7 ns
545B	DC to 33 MHz	11 ns
549	DC to 30 MHz	12 ns
551	DC to 27 MHz	13 ns
535A	DC to 15 MHz	24 ns

**A Type 81A Adapter is required.

†Low-frequency 3-dB point, AC coupled: ≤2 Hz, ≤0.2 Hz with 10X probe.

DEFLECTION FACTOR

10 mV/cm to 20 V/cm in 11 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/cm.

INPUT RC

1 megohm (±1%) paralleled by approx 20 pF.

MAXIMUM INPUT VOLTAGE

600 V DC + peak AC.

*Early Type 555 Oscilloscopes using Type 21 and 22 Time Base Units require a minor modification.

DISPLAY MODES

Any single-channel; any two channels (alternated, chopped, or added); three channels (alternated, chopped, or added in any combination); and four channels (Channels 1 and 2 alternated, chopped, or added with Channels 3 and 4). Four channel addition is useful in single-shot displays of four different signals, as in delay and coincidence studies.

Channels are always displayed in numerical sequence in chopped and alternate modes. One channel will run twice when only three are turned on. In chopped operation, successive 2.5-μs (approx) segments of each channel are displayed. Chopping rate is approx 400 kHz. Chopped transient blanking with all oscilloscopes except Type 551, and 585A.

DISPLAY SWITCHING with Type 547 and RM547 Oscilloscopes

Alternate switching circuit in the Type 1A4 can be slaved to the Automatic Display Switching in Type 547 and RM547 Oscilloscopes to lock Channels 1 and 2 to Time Base A, and Channels 3 and 4 to Time Base B. For dual-trace slaving, Channel 1 or 2 is alternated with Channel 3 or 4. Alternation of up to 8 traces with each signal displayed on 2 different time bases is also possible when the 1A4 is not slaved to the oscilloscope.

COMMON-MODE REJECTION

At least 20:1, DC to 10 MHz common-mode signals up to 10 cm in amplitude.

CHANNEL ISOLATION

At least 50:1 for signals from DC to 20 MHz.

Four-Trace Amplifier

1A4

SIGNAL OUTPUT AND TRIGGER SOURCE

Signal from any channel can be used to externally trigger the oscilloscope, thus indicating the true time relationship between signals displayed in alternate and chopped mode. Selected output also applied internally to Type 544, 546, 547, 549 and 556 Oscilloscopes. The front-panel output can also be cascaded with another channel, providing additional gain useful in many applications. Signal output amplitude is >0.5 V/cm of display signal, unterminated at 1 kHz. Bandwidth is ≤20 Hz to ≥10 MHz (to approx 500 kHz with any channel operated in chopped mode). Approx 50-Ω output impedance.

WEIGHTS

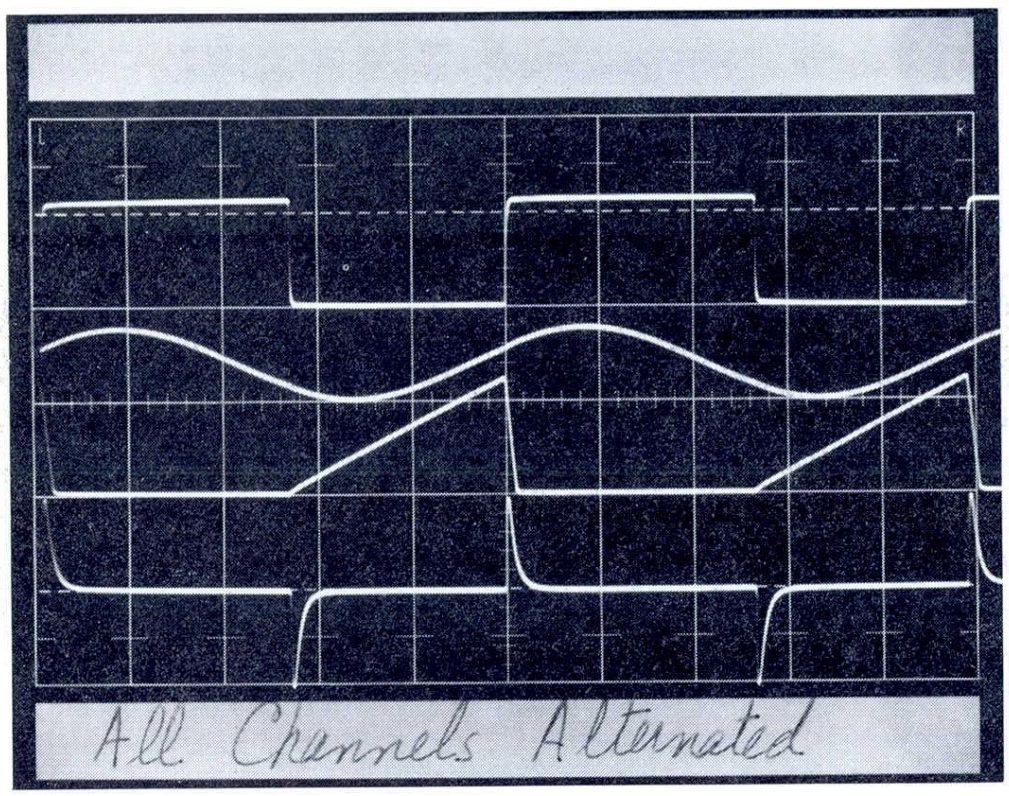
Net weight	6½ lb	3.1 kg
Domestic shipping weight	≈10 lb	≈4.5 kg
Export-packed weight	≈16 lb	≈7.3 kg

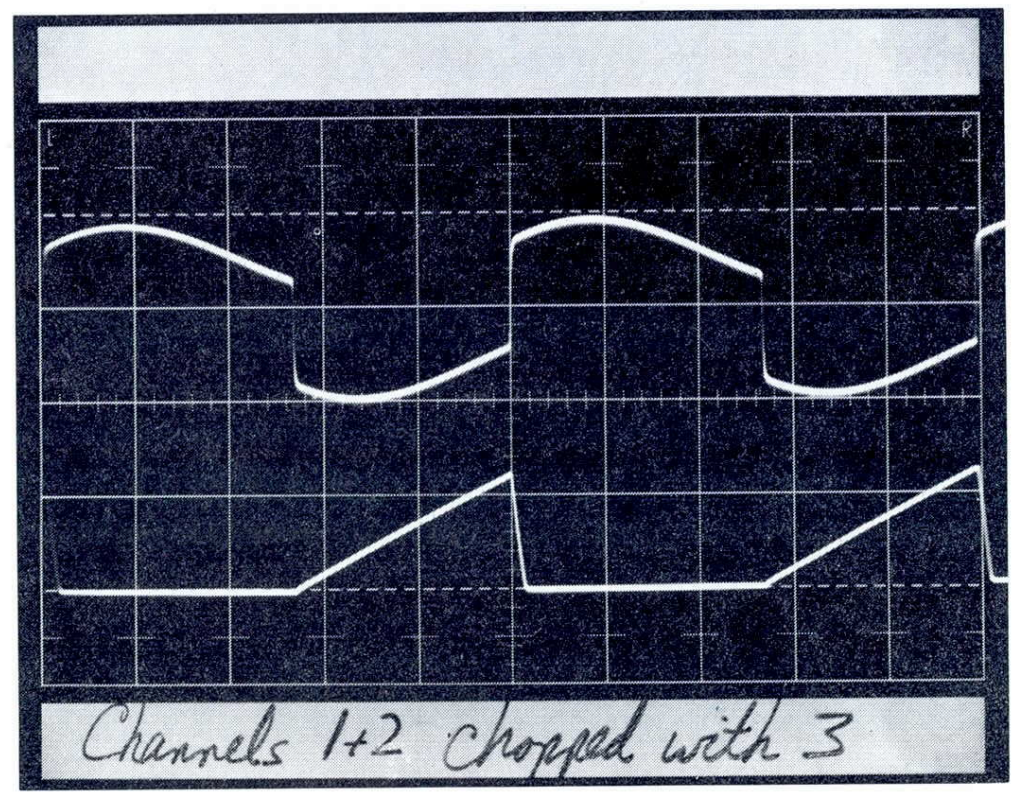
INCLUDED STANDARD ACCESSORIES

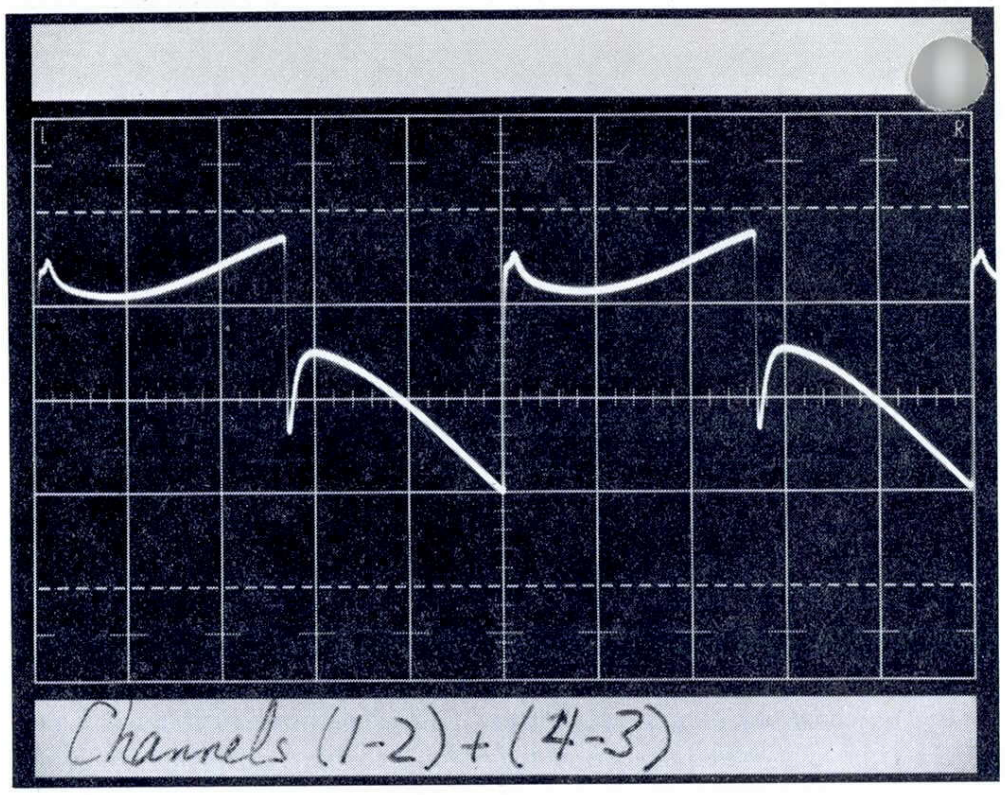
BNC-to-BNC 18-inch cable (012-0076-00); two instruction manuals (070-0545-00).

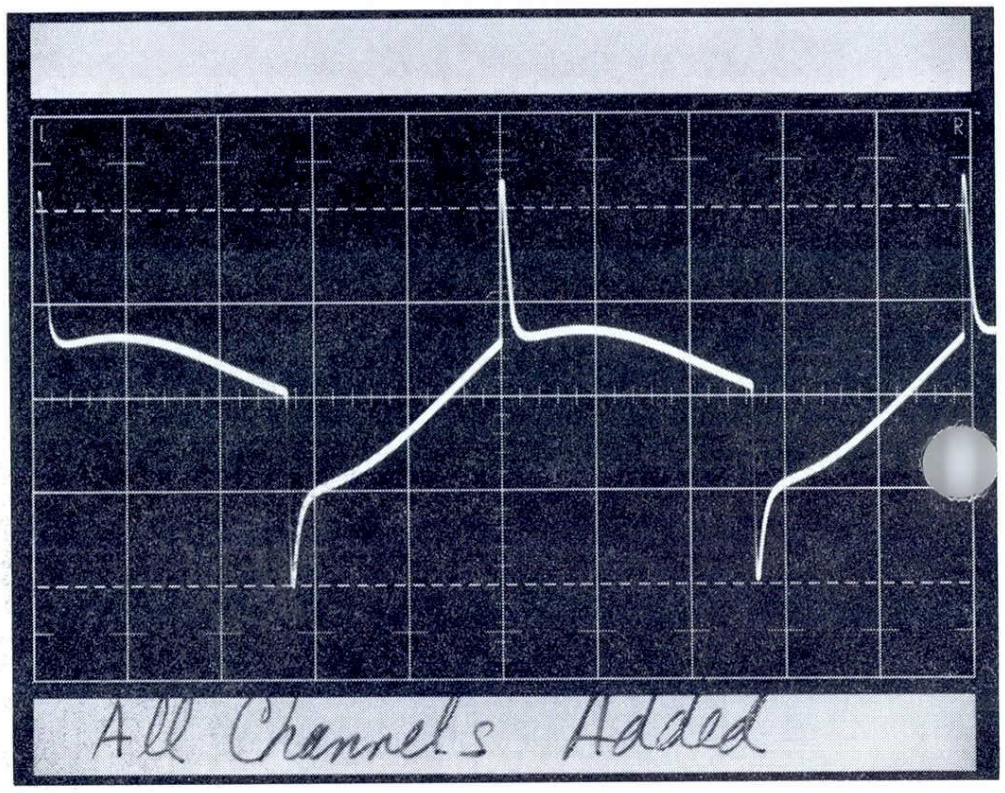
TYPE 1A4 PLUG-IN UNIT $895

SOME OF MANY POSSIBLE DISPLAY MODES









Waveforms photographed with C-12 Camera, Projected Graticule, Type 547 Oscilloscope.

OPTIONAL ACCESSORIES

The probes recommended for use with this plug-in unit satisfy most measurement requirements. Other probes are available for current and high-voltage measurements. See catalog accessory pages for additional information on these and other items.

P6008** 10X Probe Package, order 010-0129-00 ..... $46.50

P6009 100X Probe Package, order 010-0140-00 ..... $66.00

P6028 1X Probe Package, order 010-0074-00 ..... $16.50

**P6008 10X Probes included with Type 544, 546, 547 and 556 Oscilloscopes increase input resistance to 10 MΩ and decrease input capacitance to approx 7.5 pF. Bandwidth of probe and oscilloscope is 45 MHz or greater; risetime is approx 7 ns.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Single-Trace Unit

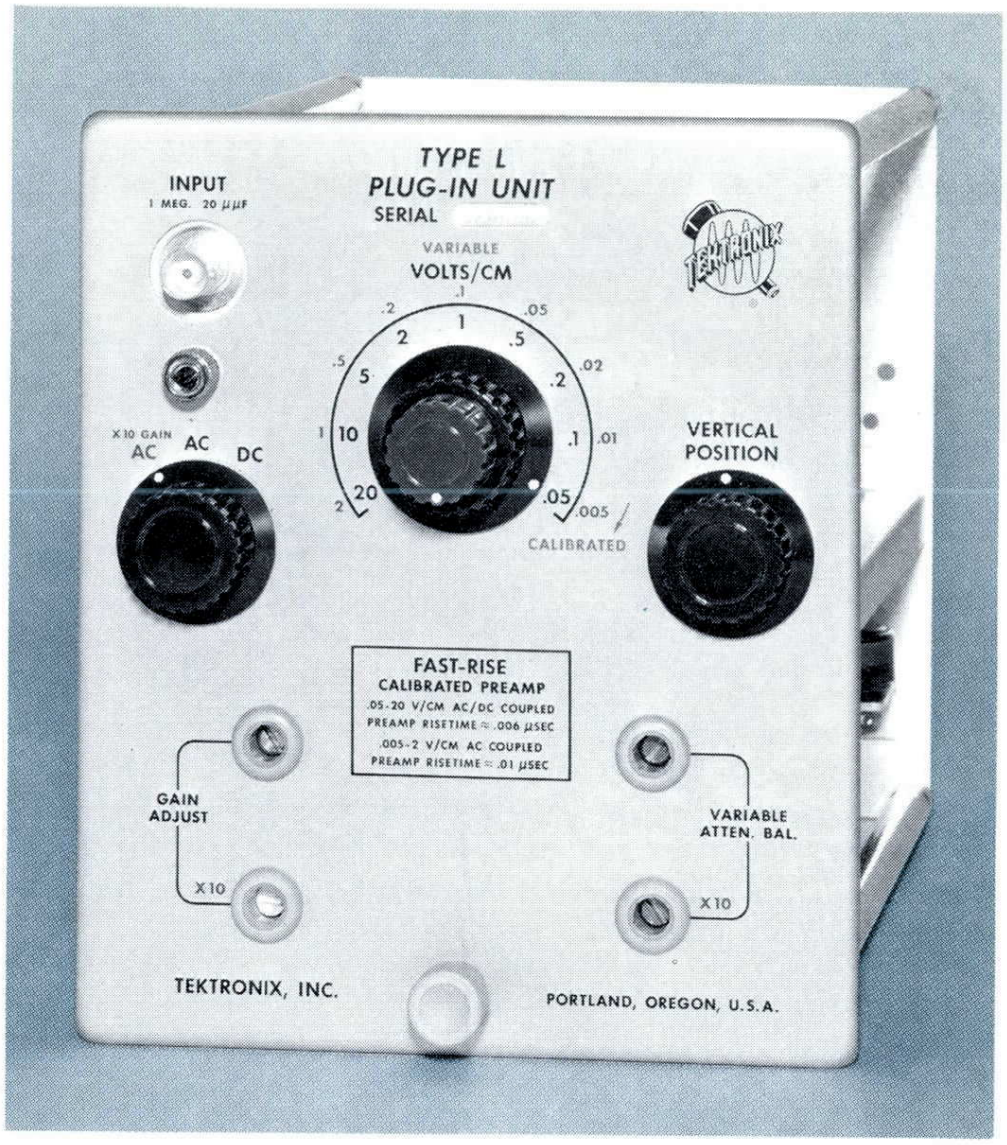
L

- ***5 mV/cm-to-20 V/cm CALIBRATED DEFLECTION FACTOR***

The Type L Fast-Rise Unit provides Type 540, 550, and 580* Series Oscilloscopes with calibrated deflection factors at low input capacitance, taking maximum advantage of the excellent transient response and wide frequency range of the oscilloscope vertical-deflection system.

The Type L offers deflection factors to 5 mV/cm, AC-coupled. An AC-coupled amplifier provides a gain of 10X with slightly reduced bandwidth.

Type 127, 132, and 133 power supplies are available to operate this plug-in outside an oscilloscope. See the description of these instruments for details.



CHARACTERISTICS

TYPE L AND OSCILLOSCOPE	DEFLECTION FACTOR	BANDWIDTH† (—3 dB)	RISE-TIME
535A	50 mV/cm to 20 V/cm 5 mV/cm to 2 V/cm	DC to 15 MHz 3 Hz to 14 MHz	24 ns 25 ns
544, 545B, 546, 547, 556, 585A*	50 mV/cm to 20 V/cm 5 mV/cm to 2 V/cm	DC to 30 MHz 3 Hz to 24 MHz	12 ns 15 ns
549	50 mV/cm to 20 V/cm 5 mV/cm to 2 V/cm	DC to 27 MHz 3 Hz to 23 MHz	13 ns 16 ns
551	50 mV/cm to 20 V/cm 5 mV/cm to 2 V/cm	DC to 25 MHz 3 Hz to 22 MHz	14 ns 16 ns

*A Type 81A Adapter is required.

†Low-frequency 3-dB point, AC coupled: 2 Hz, 0.2 Hz with 10X probe.

DEFLECTION FACTOR

50 mV/cm to 20 V/cm in 9 calibrated steps (1-2-5 sequence), accurate within 3%. 5 mV/cm to 2 V/cm in 9 calibrated steps, AC coupled, using X10 gain. Uncalibrated, continuously variable between steps and to approx 50 V/cm.

INPUT

1 megohm paralleled by approx 20 pF.
600 V DC + peak AC max input voltage.

WEIGHTS

Net weight	4¼ lb	1.9 kg
Domestic shipping weight	≈ 7 lb	≈3.2 kg
Export-packed weight	≈12 lb	≈5.5 kg

INCLUDED STANDARD ACCESSORIES

Two instruction manuals (070-0336-00).

TYPE L PLUG-IN UNIT **$260**

OPTIONAL ACCESSORIES

The probes recommended for use with this plug-in unit satisfy most measurement requirements. Other probes are available for current and high-voltage measurements. See catalog accessory pages for additional information on these and other items.

P6006* 10X Probe Package, order 010-0127-00 . . . . . $29.00

P6007 100X Probe Package, order 010-0150-00 . . . . . $29.00

P6028 1X Probe Package, order 010-0074-00 . . . . . $16.50

*Included with Type 535A, 545B, 549, and 551 Oscilloscopes.

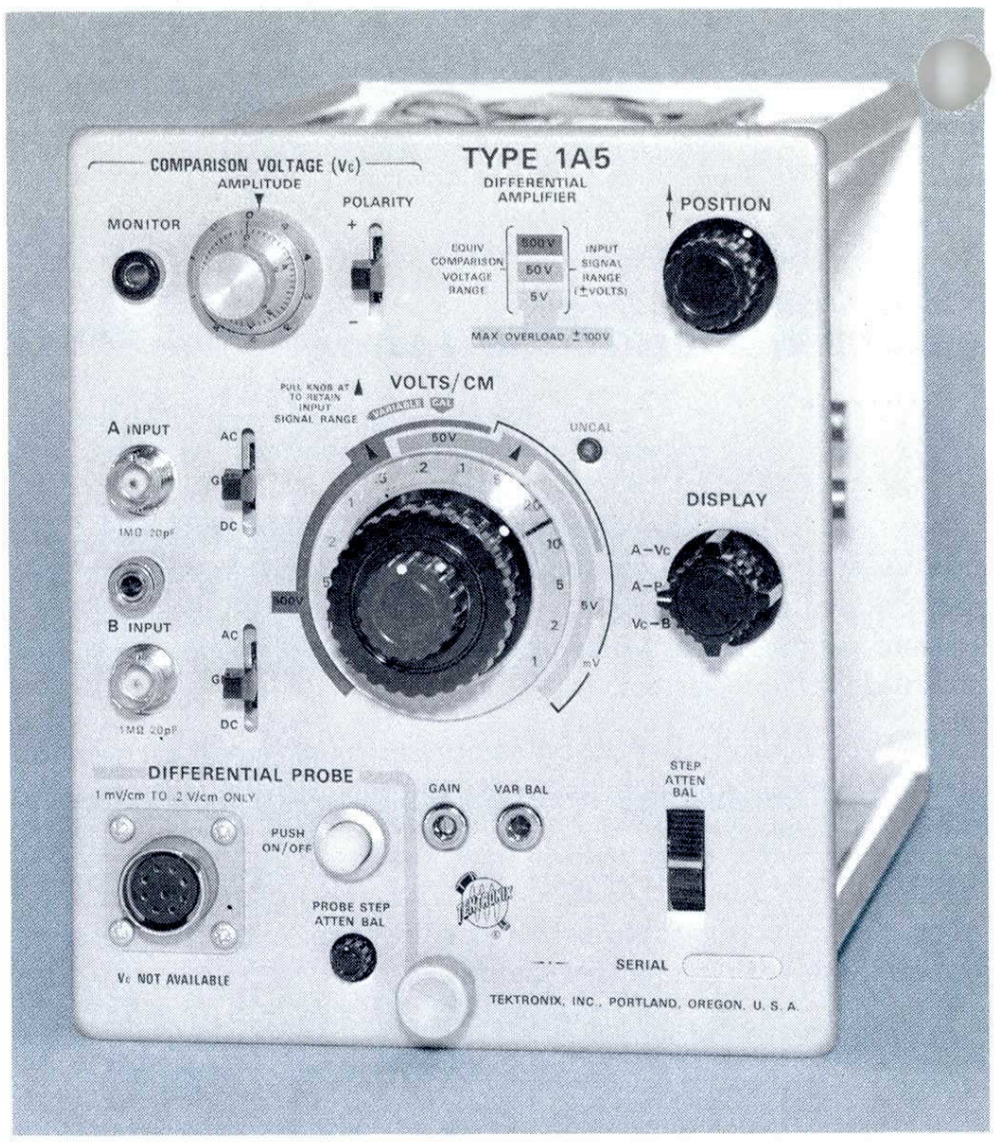
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

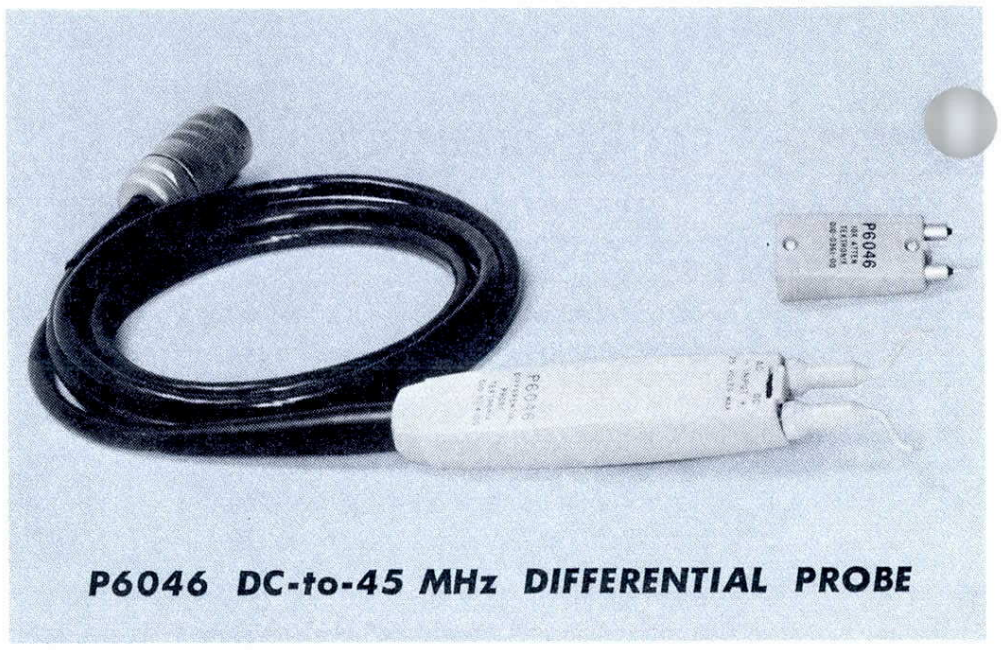
1A5 Wide-Band Differential Comparator Amplifier 1A5

- ***1 mV/cm-to-20 V/cm CALIBRATED DEFLECTION FACTOR***
- ***≥10,000:1 COMMON-MODE REJECTION FROM DC TO 1 MHz***
- ***LOW DC DRIFT, NON MICROPHONIC***
- ***±5-V COMPARISON VOLTAGE***
- ***SOLID-STATE DESIGN, FET INPUTS***

This wide-band differential unit for Type 530, 540, 550, and (with adapter) 580-Series Oscilloscopes achieves a new high in common-mode rejection. Gain-bandwidth products exceed those previously available in a differential amplifier. Maximum bandwidth is obtained with Type 544, 546, 547, 556, and 585A* Oscilloscopes. Type 127, 132, and 133 Power Supplies are available to operate the Type 1A5 outside an oscilloscope. See the description of these instruments for details.

Solid state design, with FET inputs, provides low drift and eliminates microphonics.





P6046 DC-to-45 MHz DIFFERENTIAL PROBE

CHARACTERISTICS

TYPE 1A5 UNIT AND OSCILLOSCOPE	DEFLECTION FACTOR	BANDWIDTH† (—3 dB)	RISE-TIME
544, 546, 547, 556, 585A*	5 mV/cm to 20 V/cm 2 mV/cm 1 mV/cm	DC to 50 MHz DC to 45 MHz DC to 40 MHz	7 ns 8 ns 9 ns
545B	5 mV/cm to 20 V/cm 2 mV/cm 1 mV/cm	DC to 33 MHz DC to 31 MHz DC to 30 MHz	11 ns 12 ns 12 ns
549	5 mV/cm to 20 V/cm 2 mV/cm 1 mV/cm	DC to 30 MHz DC to 29 MHz DC to 28 MHz	12 ns 13 ns 13 ns
551	5 mV/cm to 20 V/cm 2 mV/cm 1 mV/cm	DC to 27 MHz DC to 26 MHz DC to 25 MHz	13 ns 14 ns 14 ns
535A	5 mV/cm to 20 V/cm 2 and 1 mV/cm	DC to 15 MHz DC to 14 MHz	24 ns 25 ns

†Low-frequency 3-dB point, AC coupled: ≤2 Hz.

*A Type 81A Adapter is required.

DEFLECTION FACTOR

1 mV/cm to 20 V/cm in 14 calibrated steps (1-2-5 sequence), accurate within 2.5% (within 2% from 1 mV/cm to 20 mV/cm). Uncalibrated, continuously variable between steps and to ≥ 50 V/cm.

INPUT RC

1 megohm paralleled by approx 20 pF.

INPUT COUPLING

May be switched to AC, GND, or DC. Input coupling capacitor is automatically charged to proper voltage through a 1-megohm resistor when switch is in GND position.

MAXIMUM INPUT VOLTAGE

±100 V (DC + peak AC) from 1 mV/cm to 20 mV/cm, ±500 V (DC + peak AC) from 10 mV/cm to 20 V/cm.

COMMON-MODE DYNAMIC RANGE

≥±5 V (DC + peak AC) from 1 mV/cm to 20 mV/cm, ≥±50 V from 50 mV/cm to 0.2 V/cm, ≥±500 V from 0.5 V/cm to 20 V/cm. The ±50-V range can be extended from 50 mV/cm to 10 mV/cm, and the ±500-V range can be extended from 0.5 V/cm to 0.1 V/cm by pulling and turning the V/cm control.

1A5 Wide-Band Differential Comparator Amplifier 1A5

COMMON-MODE REJECTION RATIOS*

FREQUENCY	REJECTION RATIO	SINEWAVE AMPLITUDE	DEFLECTION FACTOR
DC to 100 kHz	≥20,000:1	±5 V P to P	1 mV/cm to 20 mV/cm
100 kHz to 1 MHz	≥10,000:1	±5 V P to P	1 mV/cm to 20 mV/cm
1 MHz to 10 MHz	≥10,000:1 divided by freq. in MHz	±5 V P to P divided by freq. in MHz	1 mV/cm to 20 mV/cm
DC to 10 kHz	≥2,000:1	±50 V P to P	10 mV/cm to 2 V/cm
DC to 10 kHz	≥100:1	±50 V P to P	5 V/cm to 20 V/cm
60 Hz (AC coupled)	≥1,000:1	±5 V P to P	1 mV/cm to 20 mV/cm

*At 0°C to 50°C

DC DRIFT

With time: ≤200 μV/h at 25°C. With temperature: ≤200 μV/°C. With line voltage change: ≤300 μV from 105 to 125 VAC.

NOISE

≤50 μV RMS.

DC SHIFT DUE TO OVERDRIVE

Within 1% of ± overdrive signal, but not exceeding 10 mV in the 5-V input signal range, 0.1 V in the 50-V input signal range, or 1.0 V in the 500-V input signal range.

OVERDRIVE RECOVERY

Recovers to within 10 mV of DC-shifted level after 0.15 μs in the 5-V input signal range.

COMPARISON VOLTAGE

0 to ±5 V, internally applied to + input or — input, monitorable at front panel. Accuracy within 7 mV or 0.5% of comparison voltage, whichever is greater.

WEIGHTS

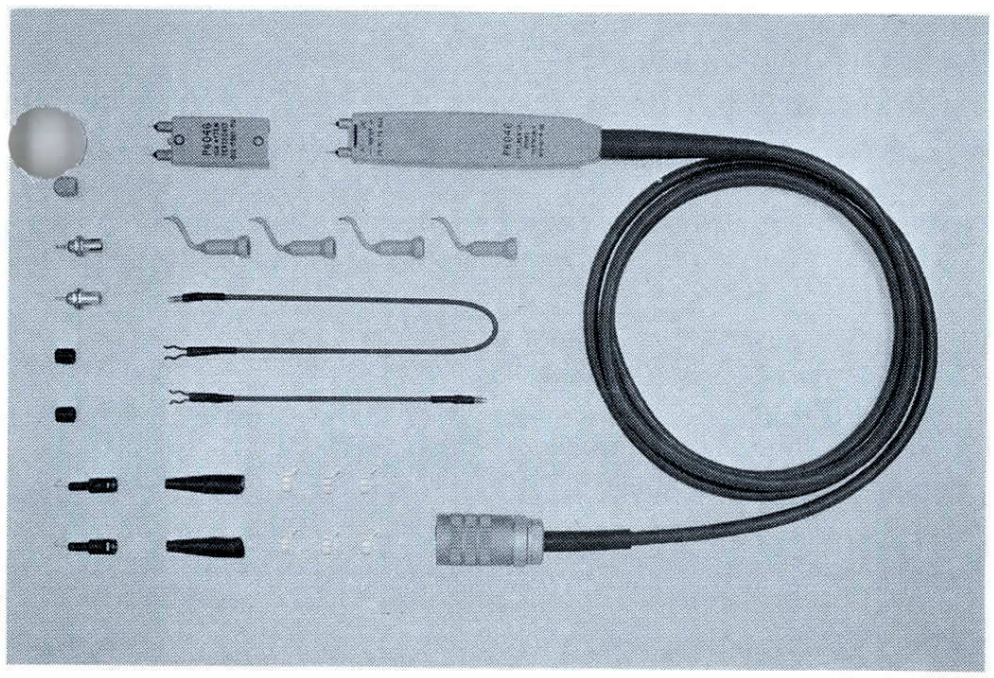
Net weight	5 lb	2.3 kg
Domestic shipping weight	≈ 7 lb	≈3.2 kg
Export-packed weight	≈13 lb	≈5.9 kg

INCLUDED STANDARD ACCESSORIES

Two instruction manuals (070-0638-00).

TYPE 1A5 PLUG-IN UNIT **$625**

P6046 Differential Probe



The P6046 expands the differential measurement capabilities of the Type 1A5 Plug-In Unit. With this new probe, the differential-signal-adding takes place in the probe itself, resulting in high common-mode signal rejection at higher frequencies. This differential probe-tip performance minimizes the measurement errors caused by differences in probes, cable lengths, and input attenuators. In addition, the wide-band capability of the P6046 assures DC-to-45 MHz performance at the probe tip where the measurements are made.

CHARACTERISTICS

Probe with Type 1A5 Plug-In Unit

ATTENUATION is 1X.

INPUT RESISTANCE is 1 megohm, ±1%.

INPUT CAPACITANCE is approx 10 pF.

COMMON-MODE LINEAR DYNAMIC RANGE is ±5 V (DC + peak AC), ±50 V with 10X attenuator.

COMMON-MODE REJECTION RATIOS with deflection factors of 1 mV/cm to 20 mV/cm are 10,000:1 at DC, 1,000:1 at 45 MHz. Min AC-coupled CMRR from 1 mV/cm to 20 mV/cm is 1000:1 at 20 MHz decreasing to 500:1 from 40 MHz to 45 MHz.

BANDWIDTH/RISETIME

TYPE 1A5 DEFLECTION FACTOR	BANDWIDTH*	RISETIME*
200 mV/cm to 5 mV/cm	DC to 45 MHz	7.8 ns
2 mV/cm	DC to 43 MHz	8.1 ns
1 mV/cm	DC to 38 MHz	9.2 ns

*With Oscilloscope Types 544, 546, 547, 556, or 585A with Type 81A Adapter.

MAXIMUM INPUT VOLTAGE is ±25 V (DC + peak AC), ±250 V with 10X attenuator.

NOISE (periodic and random deviation) is 200 μV or less.

THERMAL DRIFT at the probe head is 250 μV/°C or less.

PROBE CABLE is 6 feet long, terminated with a special nine-pin connector.

P6046 PROBE PACKAGE (010-0213-00) **$470**

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Differential Amplifier

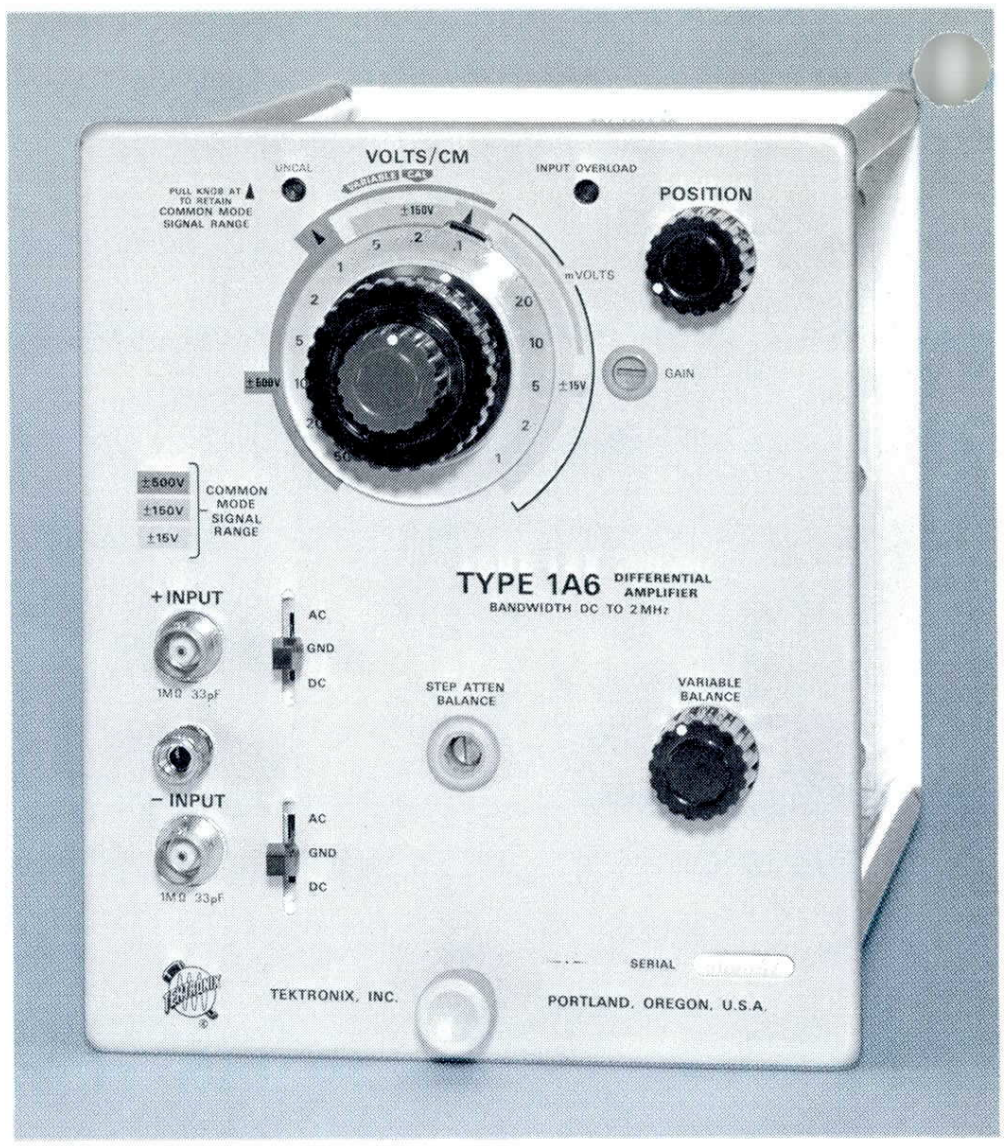
1A6

- ***1 mV/cm-to-50 V/cm CALIBRATED DEFLECTION FACTOR***
- ***CONSTANT BANDWIDTH***
- ***10,000:1 COMMON-MODE REJECTION***
- ***±15-V COMMON-MODE SIGNAL RANGE***
- ***SOLID-STATE DESIGN***

The Type 1A6 Plug-In Unit is a DC coupled differential amplifier designed for Tektronix 530, 540, 550 and 580* Series Oscilloscopes. It features a differential input with a high rejection ratio for in-phase signals, allowing the cancellation of unwanted or interfering signals. The differential measuring capability is particularly useful in the display of instantaneous voltage difference between signals.

The plug-in unit is simple to operate. Only one control is used to select the deflection factor and the common-mode signal range.

Type 127, 132, and 133 Power Supplies are available to operate the Type 1A6 outside an oscilloscope. See the description of these instruments for details.



CHARACTERISTICS

BANDWIDTH

DC to ≥2 MHz (≤2 Hz to ≥2 MHz AC-coupled) at 3-dB down. Bandwidth independent of deflection factor.

RISETIME

≤0.18 μs.

DEFLECTION FACTOR

1 mV/cm to 50 V/cm in 15 calibrated steps, 1-2-5 sequence; ±1.5% accuracy from 1 mV/cm to 50 mV/cm, ±2.5% accuracy from 0.1 V/cm to 50 V/cm. Uncalibrated continuous variation between steps and to approx 125 V/cm.

INPUT RC

1 megohm paralleled by 33 pF.

MAXIMUM INPUT VOLTAGE

DC coupled: 1 mV to 50 mV — ±200 V (DC + peak AC)
0.1 V to 50 V — ±600 V (DC + peak AC)
AC coupled: 1 mV to 50 mV — ±200 V (AC peak to peak)
0.1 V to 50 V — ±600 V (DC + peak AC)

INPUT COUPLING

AC, GND, or DC. Input coupling capacitor is automatically charged to proper voltage through a 1-megohm resistor when switch is in GND position.

COMMON-MODE REJECTION

1 mV/cm to 50 mV/cm	0.1 V/cm to 50 V/cm
≥10,000:1 from DC to 100 kHz	†≥1000:1 from DC to 100 kHz
≥2000:1 at 60 Hz (AC-coupled)	≥1000:1 at 60 Hz (AC-coupled)

*A Type 81A Adapter is required. †Adjustable.

COMMON-MODE DYNAMIC RANGE

±15 V (combined DC and peak AC) from 1 mV/cm to 50 mV/cm, ±150 V from 0.1 V/cm to 0.5 V/cm, ±500 V from 1 V/cm to 50 V/cm. The ±150-V range can be extended from 0.1 V/cm to 10 mV/cm, and the ±500-V range can be extended from 1 V/cm to 0.1 V/cm by pulling and turning the V/cm control.

WEIGHTS

Net weight	4 lb	1.8 kg
Domestic shipping weight	≈ 8 lb	≈3.6 kg
Export-packed weight	≈14 lb	≈6.4 kg

INCLUDED STANDARD ACCESSORIES

Two instruction manuals (070-0537-00).

TYPE 1A6 PLUG-IN UNIT $295

OPTIONAL ACCESSORIES

The probes recommended for use with this plug-in unit satisfy most measurement requirements. Other probes are available for current and high-voltage measurements. See catalog accessory pages for additional information on these and other items.

P6007 100X Probe Package, order 010-0150-00 ..... $29.00

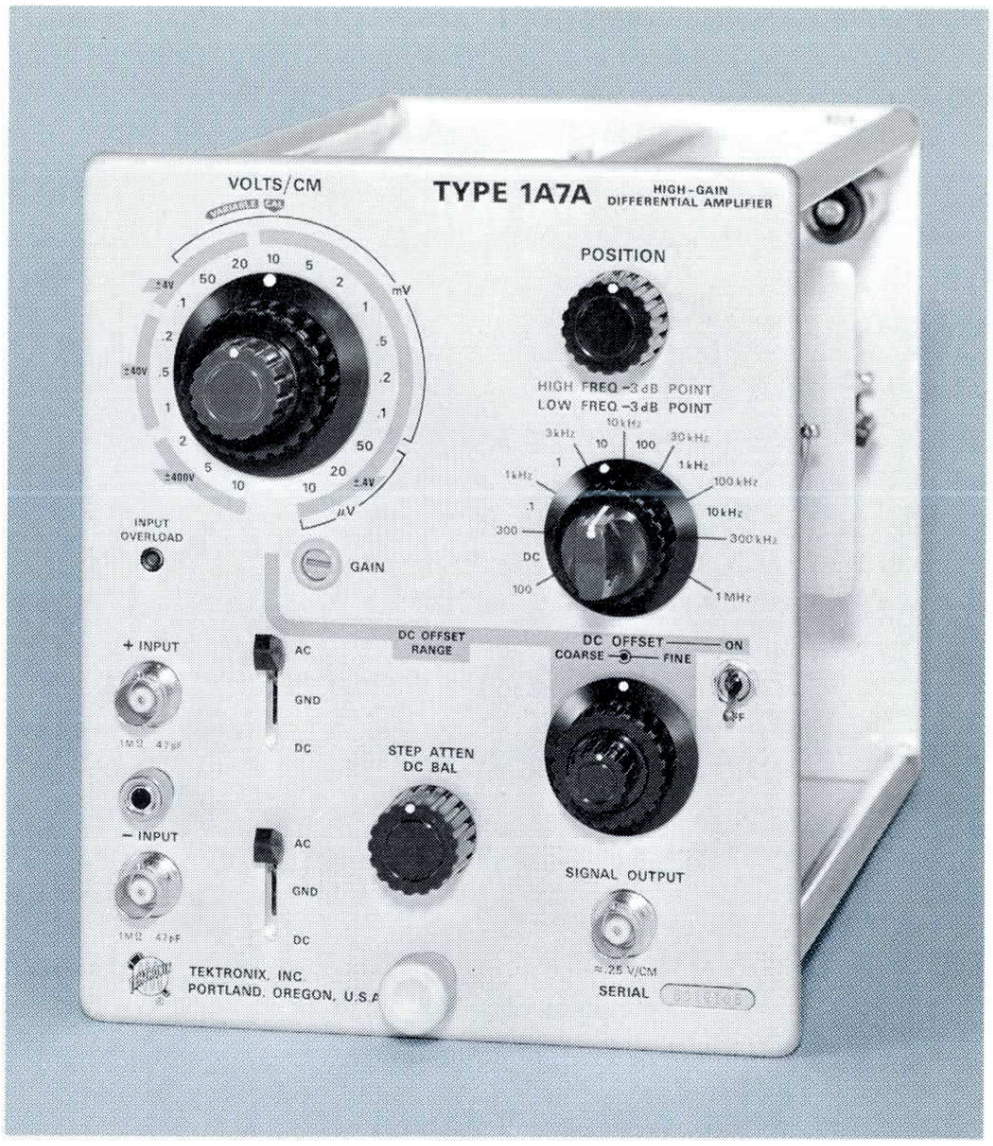
P6023 10X Probe Package, adjustable attenuation ratio helps maintain common-mode rejection, order 010-0167-00 $52.00

P6028 1X Probe Package, order 010-0074-00 ..... $16.50

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

1A7A High-CMRR High-Gain Differential Amplifier 1A7A

- *10-μV/cm BASIC DEFLECTION FACTOR*
- *DC-to-1 MHz BANDWIDTH*
- *SELECTABLE UPPER AND LOWER —3-dB POINTS*
- *100,000:1 COMMON-MODE REJECTION*
- *INTERNAL DIFFERENTIAL OFFSET*
- *ALL SOLID-STATE, FET INPUTS*
- *10-μV/HOUR DC DRIFT**



CHARACTERISTICS

Designed for use with any Tektronix 530, 540, 550, or (with Type 81A Adapter) 580-Series Oscilloscopes. Used with Type 127, 132 or 133 Power Supply, the Type 1A7A can drive recording equipment, X-Y plotters, oscilloscopes or other indicators.

Type 1A7A characteristics represent a significant performance level for high gain, differential, DC-coupled amplifiers. DC drift is held to 10 μV/h, long term, without chopper stabilization; displayed noise (tangentially measured) is 16 μV at 10 μV/cm and 1 MHz, with ≤25-Ω source resistance. Bandwidth is maintained at DC to 1 MHz throughout the deflection factor range of 10 μV/cm to 10 V/cm. CMRR is at least 100,000:1 from DC to 100 kHz at 10 μV/cm to 10 mV/cm. DC differential offset provides an internal voltage to cancel residual DC levels or inspect signal components over the full differential dynamic range.

Passband is selectable at both upper and lower 3-dB points for noise attenuation and AC coupling at very low frequency (0.1 Hz).

Input circuitry is protected (fused) against accidental severe overload. A differential overload light indicates overload is being approached.

BANDWIDTH

DC-to-1 MHz bandwidth independent of deflection factor. Selectable high and low-frequency 3-dB points.

HIGH-FREQUENCY —3-dB POINTS

1 MHz, 300 kHz, 100 kHz, 30 kHz, 10 kHz, 3 kHz, 1 kHz, 300 Hz and 100 Hz.

LOW-FREQUENCY —3-dB POINTS

0.1 Hz, 1 Hz, 10 Hz, 100 Hz, 1 kHz, and 10 kHz. DC mode is included on this control.

DEFLECTION FACTOR

10 μV/cm to 10 V/cm in 19 calibrated steps, 1-2-5 sequence, accurate within 2%. Uncalibrated continuous variation between steps and to approx 25 V/cm.

INPUT RC

1 megohm, paralleled by 47 pF.

*With constant temperature. See DC DRIFT specifications.

INPUT COUPLING

May be switched to AC, GND, or DC. Input coupling capacitor is automatically charged to proper voltage through a 1-megohm resistor when switch is in GND position. Lower —3-dB point is 1.6 Hz (±5%) when AC coupled at input.

MAXIMUM INPUT CURRENT

		at 25°C	at 50°C
10 μV/cm to 10 mV/cm	each input	±20 pA	±100 pA
	both inputs	±40 pA	±200 pA
20 mV/cm to 10 V/cm	each input	±10 pA	±10 pA
Display shift at 10 μV/cm (AC coupled)	each input	±2 cm	±10 cm

DISPLAYED NOISE

≤16 μV or 0.1 cm, whichever is greater, measured tangentially at full bandwidth (DC to 1 MHz), source resistance 25 Ω or less. See catalog glossary for definition of "tangential noise measurement".

DC DRIFT

Drift with time (ambient temperature and line voltage constant).

Short term: 5 μV/minute (P-P) after 1 hour warm up.

Long term: 10 μV/hour (P-P) after 1 hour warm up.

Drift with ambient temperature (line voltage constant): 50 μV/°C.

DIFFERENTIAL DYNAMIC RANGE

10 μV/cm to 10 mV/cm — ±400 mV
20 mV/cm to 0.1 V/cm — ±4 V
0.2 V/cm to 1 V/cm — ±40 V
2 V/cm to 10 V/cm — ±400 V

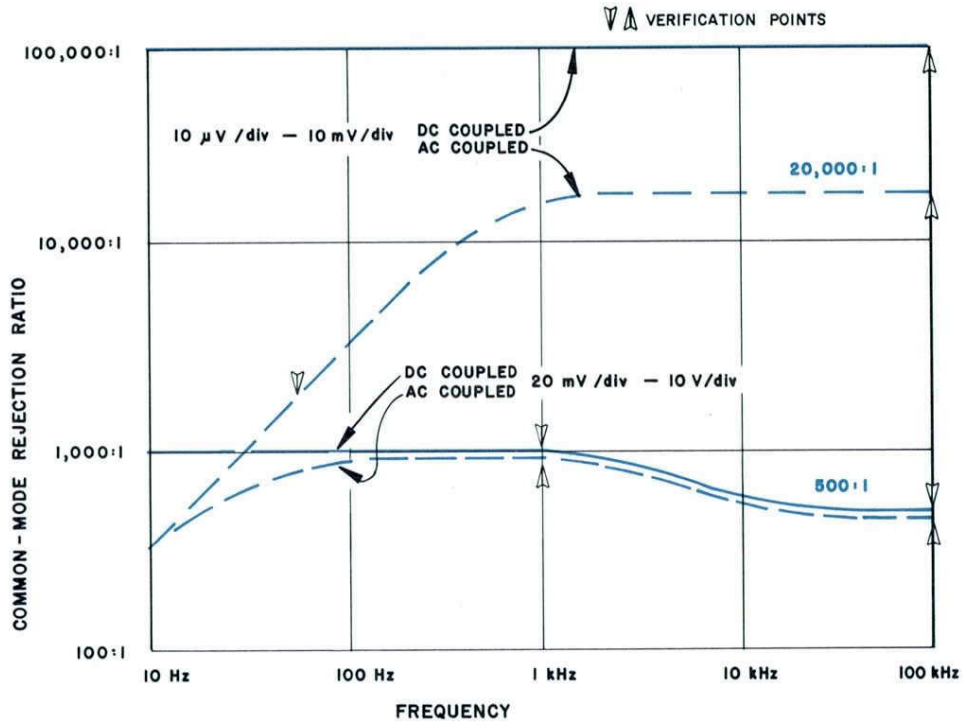
High-CMRR High-Gain Differential Amplifier

1A7A

DC OFFSET (within ±10%)

±400 mV from 10 μV/cm to 10 mV/cm; ±4 V from 20 mV/cm to 0.1 V/cm; ±40 V from 0.2 V/cm to 1 V/cm; ±400 V from 2 V/cm to 10 V/cm.

COMMON-MODE REJECTION



COMMON-MODE DYNAMIC RANGE

10 μV/cm to 10 mV/cm — ±10 V (DC + peak AC).
20 mV/cm to 0.1 V/cm — ±100 V (DC + peak AC).
0.2 V/cm to 10 V/cm — ±500 V (DC + peak AC).

MAXIMUM INPUT VOLTAGE

DC Coupled: 10 μV/cm to 10 mV/cm — ±20 V (DC + peak AC)
20 mV/cm to 10 V/cm — ±500 V (DC + peak AC)

AC Coupled Input DC Voltage:
10 μV/cm to 10 V/cm — ±500 V

OVERDRIVE RECOVERY

≤10 μs to recover within 0.5% of zero level after removal of a + or — voltage applied for 1 s, applied voltage within the differential dynamic range.

DIFFERENTIAL OVERLOAD LIGHT

Indicates differential overload is being approached.

FRONT-PANEL SIGNAL OUTPUT

0.25 V per displayed cm, ±10%. Output is DC coupled, output impedance ≤750 Ω. Minimum load resistance, 10 kΩ.

WEIGHTS

Net weight	4¾ lb	2.1 kg
Domestic shipping weight	≈ 9 lb	≈4.1 kg
Export-packed weight	≈13 lb	≈5.9 kg

INCLUDED STANDARD ACCESSORIES

Two instruction manuals (070-0782-00).

TYPE 1A7A PLUG-IN UNIT $525

OPTIONAL ACCESSORIES

The probes recommended for use with this plug-in unit satisfy most measurement requirements. Other probes are available for current and high-voltage measurements. See catalog accessory pages for additional information on these and other items.

The P6023 low-capacitance probe is well suited for use with most Tektronix differential units.

The probe can be adjusted to match plug-in unit input capacitance ranging from 20 pF to 50 pF. The X10 attenuation ratio is adjustable over a ±2.5% range to compensate for differences in the input resistance of the plug-in unit. When P6023 probes are used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other helps to maintain the common-mode rejection ratio of the system.

P6023 10X Probe Package, adjustable attenuation ratio helps maintain common-mode rejection, order 010-0167-00 $52.00

P6007 100X Probe Package, order 010-0150-00 ..... $29.00

P6028 1X Probe Package, order 010-0074-00 ..... $16.50

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

W Differential Comparator Amplifier W

- ***1 mV/cm-to-50 V/cm CALIBRATED DEFLECTION FACTOR***
- ***UP TO 23-MHz BANDWIDTH***
- ***20,000:1 COMMON-MODE REJECTION***
- ***11,000 cm EFFECTIVE SCREEN HEIGHT***

The Type W High-Gain Differential Comparator adds to the measurement capabilities of Tektronix Type 530, 540, 550 and 580* Series Oscilloscopes. Used with Type 127, 132 or 133 Power Supply, the Type W can drive recording equipment, X-Y plotters, oscilloscopes, or other indicators.

As a differential input preamplifier, the dynamic range of the W Unit permits common-mode signals up to ±15 volts in amplitude to be applied to the amplifier without attenuation. With a rejection ratio of 20,000 to 1 for DC or low-frequency signals, signals of 1 mV or less on large common-mode signals can be measured. A front-panel attenuator permits the acceptance of common-mode voltages up to 500 V.

As a differential comparator, voltage measurements using a slide-back technique can be made with this unit. The high accuracy and stability of the DC comparison voltage added differentially to the input signal makes more precise voltage measurements possible. Using this mode of operation, the W Unit has an effective screen height of ±11,000 cm. This is equivalent to a ±11-volt dynamic signal range at a deflection factor of 1 mV/cm. Within this range, calibrated ±DC comparison voltages can be added differentially to the input signal to permit a maximum of about 0.001% or 100 μV per mm to be resolved.

CONVENTIONAL PREAMPLIFIER

TYPE W UNIT AND OSCILLOSCOPE	MILLIVOLTS/CM SETTING	BANDWIDTH† (—3 dB)	RISETIME
535A	50 1	DC to 13 MHz DC to 7 MHz	27 ns 50 ns
544, 545B, 546, 547, 556, 585A*	50 1	DC to 23 MHz DC to 8 MHz	16 ns 44 ns
549	50 1	DC to 22 MHz DC to 7 MHz	16 ns 50 ns
551	50 1	DC to 20 MHz DC to 7.5 MHz	18 ns 47 ns

*A Type 81A Adapter is required.

†Low-frequency 3-dB point, AC coupled: 2 Hz, 0.2 Hz with 10X probe.

DEFLECTION FACTOR

1 mV/cm to 50 V/cm, determined by millivolts/cm and attenuator settings. Millivolts/cm positions accurate within 3%. Uncalibrated, continuously variable between steps and to approx 125 V/cm.

ATTENUATORS

4 decade steps covering range of 1 to 1,000. 10X position accurate within ±0.05%; 100X within ±0.15%, 1000X within ±3%.

INPUT

1 megohm paralleled by 20 pF (except in additional 1X attenuation position ($R \approx \infty$) where $R > 10{,}000$ megohm). Input resistance of 10X and 1X attenuators is matched within ±0.1%.

NOISE

No more than 300 μV peak to peak.

DIFFERENTIAL-INPUT PREAMPLIFIER

COMMON-MODE REJECTION RATIO

DC COUPLED: 20,000:1 from DC to 20 kHz, 500:1 at 500 kHz; with ±15 V signal applied.

AC COUPLED: 1000:1 with a 60 Hz, 30 V P-P signal applied.

MAXIMUM PEAK INPUT

±15 volts, increasing to ±150 volts with 10X attenuation and ±500 volts with 100X or 1000X attenuation.

Differential Comparator Amplifier

HIGH-RESOLUTION VOLTAGE MEASUREMENT
using the slide-back technique

A 150-volt sawtooth waveform is applied and clipped with a zener diode, shown in Figure 1. The knee of the curve is shown expanded vertically and horizontally in Figures 2 and 3. This resolution is made possible in the Type W Unit by using the slide-back technique. Figure 3 clearly shows zener noise. 10X more "vertical magnification", to 1 mV/cm, could be used, if desired.

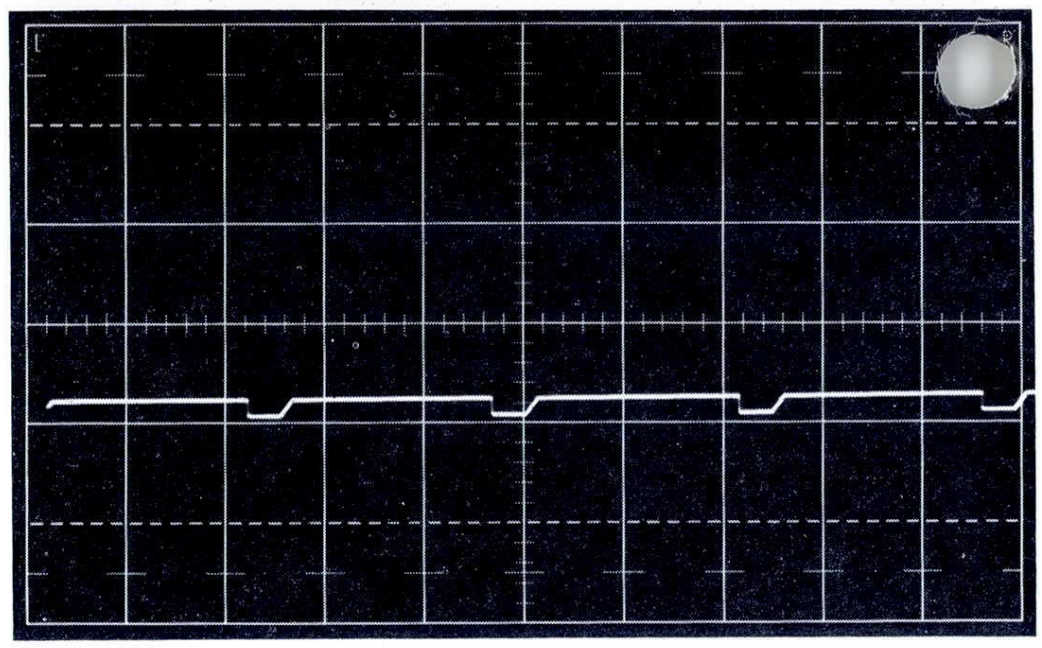


Figure 1—50 V/cm, 5 ms/cm.

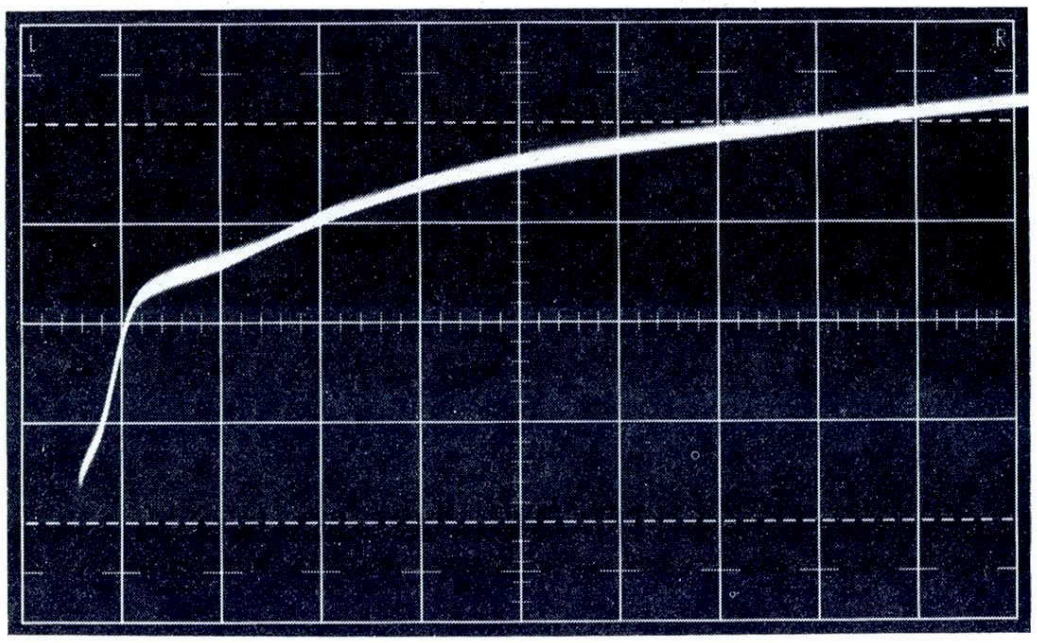


Figure 2—50 mV/cm, 0.2 ms/cm.

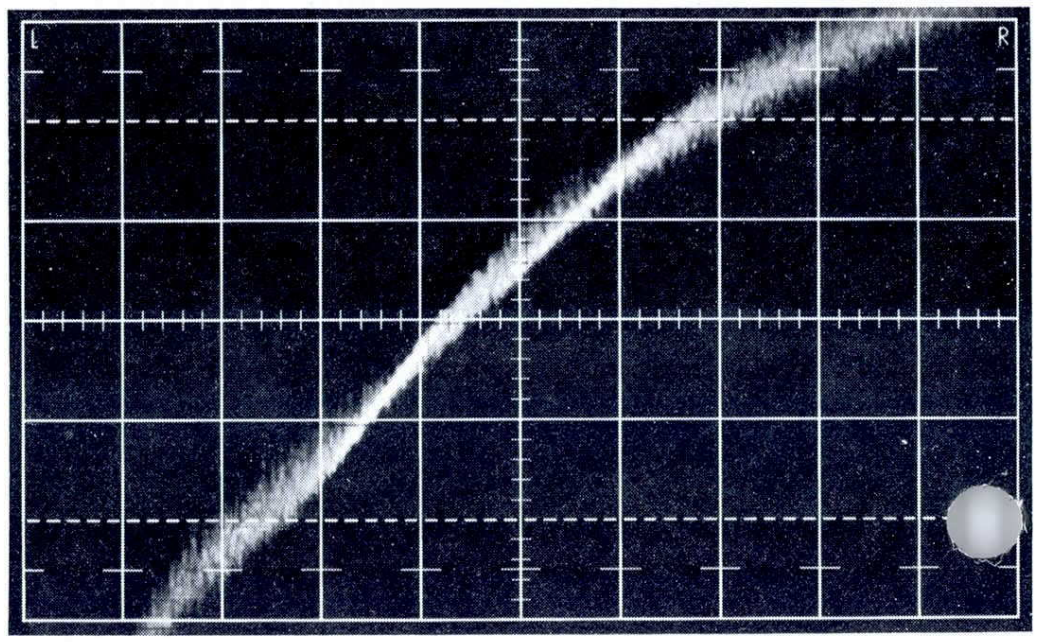


Figure 3—(Single sweep), 10 mV/cm, 100 μs/cm.

CALIBRATED DIFFERENTIAL COMPARATOR

COMPARISON VOLTAGE
0 to ±1.1 V, or 0 to ±11 V. Accuracy: ±(0.15% of indicated value plus 0.05% of Vc range).

Vc SUPPLY RESOLUTION
0 to ±1.1 V range: 100 μV per minor dial div; 0 to ±11 V range: 1 mV per minor dial div.

MAXIMUM PEAK INPUT
Same as for Differential-Input.

OVERDRIVE RECOVERY
Recovers to within 10 mV of the reference point within 300 ns after the signal returns to the screen. Certain overdrive signals can cause an additional slow (thermal) shift of up to 5 mV in the reference level (overdrive DC shift).

WEIGHTS

Net weight	5 lb	2.3 kg
Domestic shipping weight	≈8 lb	≈3.6 kg
Export-packed weight	≈12 lb	≈5.5 kg

INCLUDED STANDARD ACCESSORIES
Two instruction manuals (070-0432-00).

TYPE W PLUG-IN UNIT $625

OPTIONAL ACCESSORIES

The probes recommended for use with this plug-in unit satisfy most measurement requirements. Other probes are available for current and high-voltage measurements. See catalog accessory pages for additional information on these and other items.

P6007 100X Probe Package, order 010-0150-00 .... $29.00

P6023 10X Probe Package, adjustable attenuation ratio helps maintain common-mode rejection, order 010-0167-00 $52.00

P6028 1X Probe Package, order 010-0074-00 ..... $16.50

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Operational Amplifier

- ***TWO OPERATIONAL AMPLIFIERS***
- ***15 MHz OR GREATER GAIN-BANDWIDTH PRODUCT***
- ***2500 OR GREATER OPEN-LOOP GAIN***
- ***SELECTABLE INTERNAL Z_i AND Z_f COMPONENTS***
- ***PROVISION FOR EXTERNAL Z_i AND Z_f COMPONENTS***

The Type O Operational Amplifier Unit performs integration, differentiation, function generation, linear and nonlinear amplification. It contains two operational amplifiers and a display amplifier. Each operational amplifier has identical features, including front-panel selection of internal Z_i and Z_f components. External components can be used independently or in combination with the internal resistor-capacitor combinations. The output of either operational amplifier can be applied to the other operational amplifier; either output can be applied to the display amplifier. The results can be viewed on Tektronix Type 530, 540, 550, and 580* Series Oscilloscopes and/or fed to other devices.

Type 127, 132, and 133 Power Supplies are available to operate this plug-in unit outside an oscilloscope. See description of these instruments for details.

DISPLAY AMPLIFIER

TYPE O UNIT AND OSCILLOSCOPE	BANDWIDTH† (—3 dB)	RISETIME
535A	DC to 14 MHz	25 ns
544, 545B, 546, 547, 556, 585A*	DC to 25 MHz	14 ns
549, 551	DC to 23 MHz	16 ns

*A Type 81A Adapter is required.
†Low-frequency 3-dB point, AC coupled: 2 Hz, 0.2 Hz with 10X probe.

DEFLECTION FACTOR
50 mV/cm to 20 V/cm in 9 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/cm.

INPUT
1 megohm paralleled by approx 47 pF.
600 V DC + peak AC max input voltage.

OPERATING MODES
Signal source selection from either operational amplifier or an external signal. AC or DC coupling. The display can be inverted to provide the desired deflection polarity.

OPERATIONAL AMPLIFIERS

OPEN-LOOP GAIN
2500 minimum.

OPEN-LOOP GAIN-BANDWIDTH PRODUCT
15 MHz or greater; checked at 10 MHz for open-loop gain greater than 1.5.

CLOSED-LOOP BANDWIDTH
750 kHz or greater at unity gain with internal input and feedback resistors, up to 10 MHz with external compensation (such as provided by the optional Compensating Adapter).

OUTPUT RANGE
$\pm$50 V, $\pm$5 mA.

OUTPUT DC LEVEL
Adjustable to ground at front panel.

OUTPUT IMPEDANCE
Approx 30 Ω at 1 MHz for compensated unity-gain amplifier.

DRIFT
Typically $<$10 mV/hour referred to input (after warmup).

NOISE
Typically $<$0.5 mV peak-to-peak (equivalent input noise), approx 3 mV peak-to-peak additional output noise when R_f = 1 megohm.

GRID CURRENT
$<$0.5 nA for each input grid; adjustable to $<$0.3 nA for —grid and $<$0.15 nA for +grid.

CROSSTALK BETWEEN AMPLIFIERS
$\geq$300:1 with 1-kHz squarewave.

FEEDBACK
Provision for negative and/or positive feedback. Negative feedback utilizes internal and/or external impedances; positive feedback utilizes external impedances only.

SELECTABLE INPUT AND FEEDBACK COMPONENTS
Front-panel switches allow independent selection of the following resistors and capacitors in any combination as Z_i and Z_f: 10, 100, 200 and 500 kΩ, 1 MΩ; 10 and 100 pF, 0.001, 0.01, 0.1, and 1 μF. All values are $\pm$1% except 10 and 100 pF which are adjustable.

INTEGRATION LOW-FREQUENCY REJECT
For high-frequency integration applications, reduces integration of drift and signals below approx 1 Hz or 1 kHz; can be switched out when desired.

Operational Amplifier

TERMINAL ADAPTERS

Two shielded adapters included for construction of external circuitry for custom applications. Suggested circuits for special applications are shown in the instruction manual.

WEIGHTS

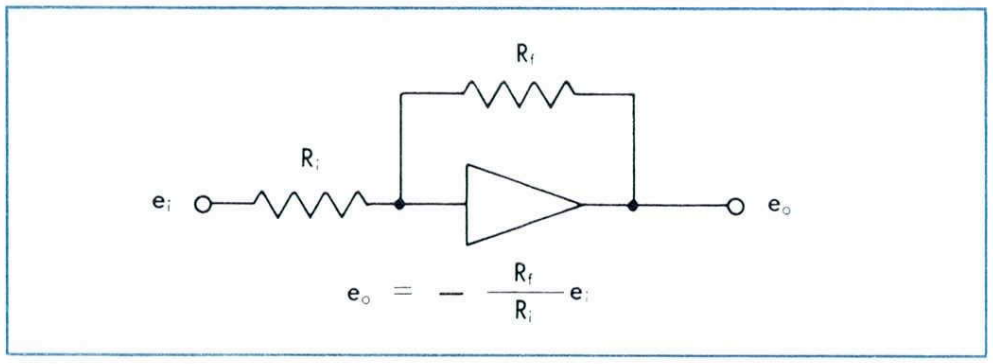
Net weight	5½ lb	2.5 kg
Domestic shipping weight	≈10 lb	≈4.5 kg
Export-packed weight	≈14 lb	≈6.4 kg

INCLUDED STANDARD ACCESSORIES

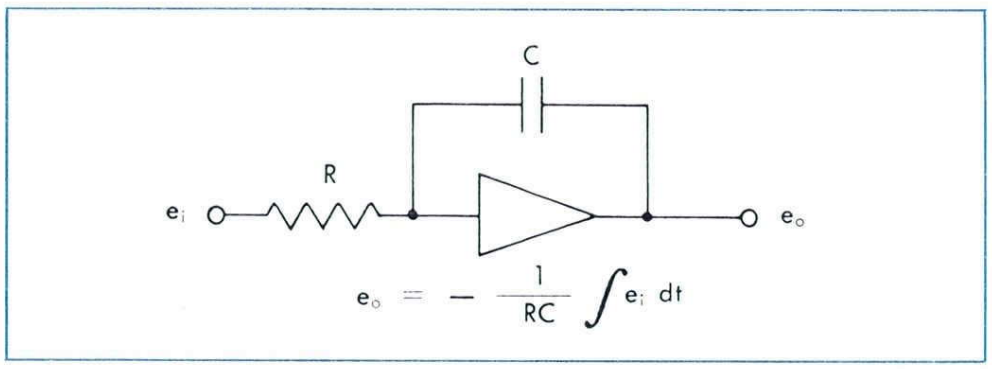
Two terminal adapters (013-0048-01); two terminal shields (013-0049-01); two BNC-to-binding post adapters (103-0033-00); two BNC-to-BNC 18-inch patch cords (012-0087-00); two instruction manuals (070-0323-00).

TYPE O PLUG-IN UNIT **$625**

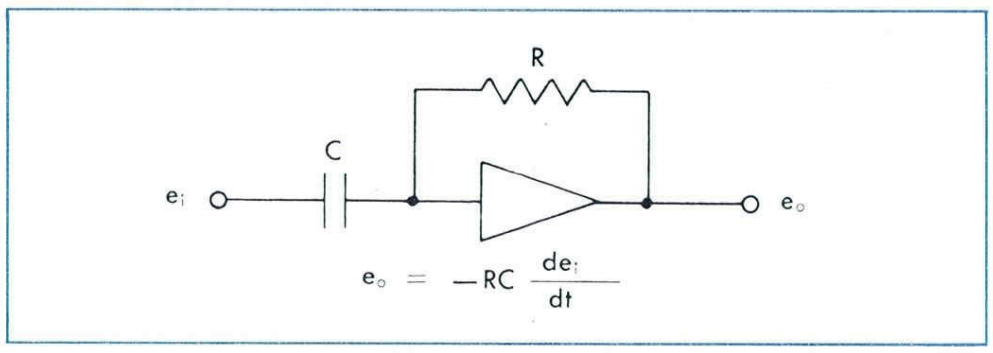
BASIC OPERATING MODES



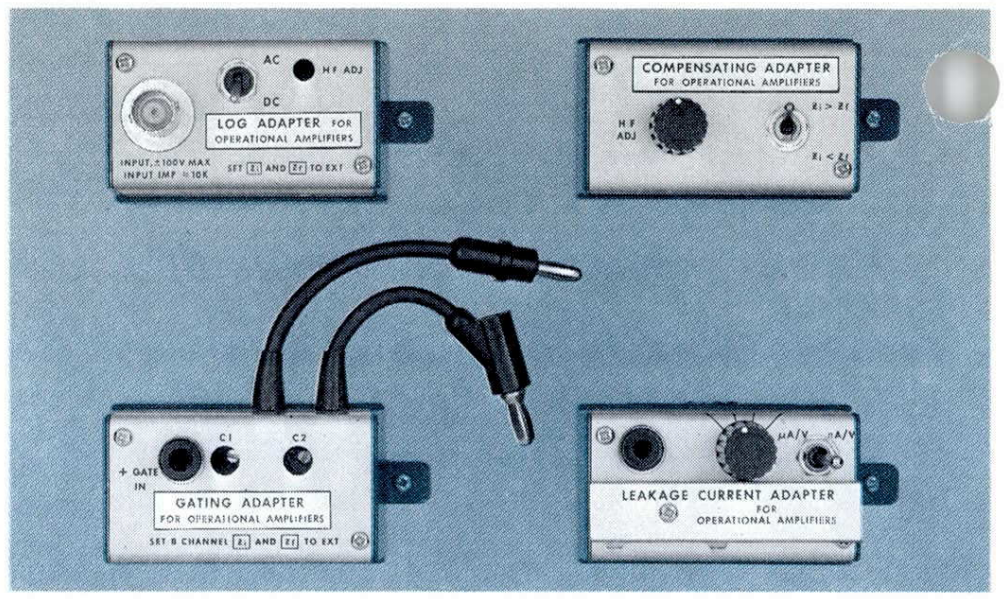
AMPLIFICATION is determined by the ratio of input to feedback resistors. This provides convenient signal step-up or step-down, with low output impedances, to over 750 kHz. Use of external compensation extends the closed-loop gain-bandwidth product to 10 MHz or more.



INTEGRATION is obtained by placing a capacitor in the feedback loop. Unlike the RC integrator, this circuitry permits loading of the output, and integration without loss of signal level. Integration at repetition rates of approximately 5 MHz is possible. Low-frequency rejection allows drift-free repetitive-waveform integration.



DIFFERENTIATION is accomplished by placing a capacitor in the input circuit. The unique characteristic of differentiation is its ability to extract higher frequency waveform components. It can advantageously detect minute information such as transients and slope changes. Differentiation of waveforms with significant components as high as 1.5 MHz is possible.



OPTIONAL ACCESSORIES

LOG ADAPTER

The Log Adapter with the Type O Plug-In Unit allows the display and measurement of high-amplitude signals mixed with low-amplitude signals. Pulses and transient waveforms differing in amplitude by up to 1000 to 1 can be displayed and measured on the same trace.

The Log Adapter is a logarithmic feedback network that converts the A or B operation amplifier in a Type O Plug-In Unit from a linear amplifier to essentially a logarithmic amplifier. The adapter can be plugged directly into the jacks on the front panel of the Type O Plug-In Unit.

Order 013-0067-00 ..... $83

COMPENSATING ADAPTER

The Compensating Adapter extends the high-frequency performance of either operational amplifier of the Type O Plug-In Unit when the internal Z_i and Z_f resistors are used in any combination for either gain or attenuation.

Without the Compensating Adapter, stray capacitance associated with the internal Z_i and Z_f resistors limits the operational amplifiers high-frequency performance. The adapter can be plugged into the front panel of the Type O Plug-In Unit.

Order 013-0081-00 ..... $39

GATING ADAPTER

The Gating Adapter allows integration and display of repetitive signals, by resetting the integrator to zero during the oscilloscope's retrace time. The adapter uses Operational Amplifier "B" of the Type O to gate Amplifier "A" on and off in response to an external gating signal, such as the +Gate from the oscilloscope. The signal applied to Amplifier "A" is then amplified, integrated, or differentiated only during the "on" time.

Order 013-0068-00 ..... $83

LEAKAGE CURRENT ADAPTER

Used with the Type O Plug-In Unit, the Leakage Current Adapter provides the facility for measuring leakage current of semiconductor diodes and small signal transistors.

The adapter plugs into the operational jacks located on the front panel of the Type O Unit. A positive-going sawtooth voltage is required for driving the adapter. Tektronix Oscilloscopes that accept the Type O Plug-In Unit have a Sawtooth or Sweep-Out jack conveniently located on the front panel for supplying the required sawtooth voltage.

Order 013-0086-00 ..... $94

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Q Transducer & Strain-Gage Amplifier Q

- ***HIGH GAIN***
- ***LOW NOISE***
- ***ESSENTIALLY DRIFT FREE***

The Type Q Plug-In Unit permits any Tektronix Type 530, 540, 550, or 580* Series Oscilloscope to be operated with strain gages and other transducers. Designed to measure any mechanical quantity that can be converted to a change in resistance, capacitance, or inductance—through use of a suitable transducing device—this versatile unit provides high gain, low noise, and extremely-low drift. Suppressed-carrier amplitude modulation is produced by unbalancing an AC bridge with the strain gages or other transducers. Phase-sensitive demodulation produces the proper deflected-trace direction.

Requiring no external equipment other than the strain gages or transducers operated with it and the associated oscilloscope, the Tektronix Type Q Plug-In Unit bridges the gap between mechanical engineering and electronic instrumentation. Total range of applications is as broad as the mechanical field itself. Applications include stress analysis, vibration studies, and fatigue tests. Typical quantities that can be measured with the unit are force, displacement, acceleration, and strain.

Type 127, 132, and 133 Power Supplies are available to operate this plug-in outside an oscilloscope. See the description of these instruments for details.

BANDWIDTH
DC to 6 kHz at 3-dB down.

RISETIME
Approximately 60 μs.

CALIBRATED DEFLECTION FACTOR
10 μstrain (microinches per inch) /div to 10,000 μstrain/div in 10 calibrated steps (1-2-5 sequence), when used with a single strain gage having a gage factor of approx 2. With four active arms and a gage factor of 2, deflection factor extends to 2.5 μstrain/div. Attenuator accurate within 2%. Uncalibrated, continuously variable between steps and to approx 25,000 μstrain/div. Warning light indicates uncalibrated setting.

AMPLIFIER INPUT
Input is to an AC bridge with 25-kHz excitation voltage. One or more of the four bridge arms can have transducers attached to them. Total bridge voltage is approximately 5 V RMS, regulated.

*A Type 81A Adapter is required.

NOISE
Typically equivalent to an input of 1.5 microstrain (peak to peak) at maximum calibrated sensitivity. This approximates an RMS noise of 0.5 microstrain.

DRIFT
Drift of the over-all system is primarily a function of the transducer stability. The Type Q Amplifier system is essentially drift free.

GAGE FACTORS
Factors from 1 to 6 are usable without changing the steps of the μstrain/div control. The range of factors is compensated for by adjusting the Gain Adjust Control.

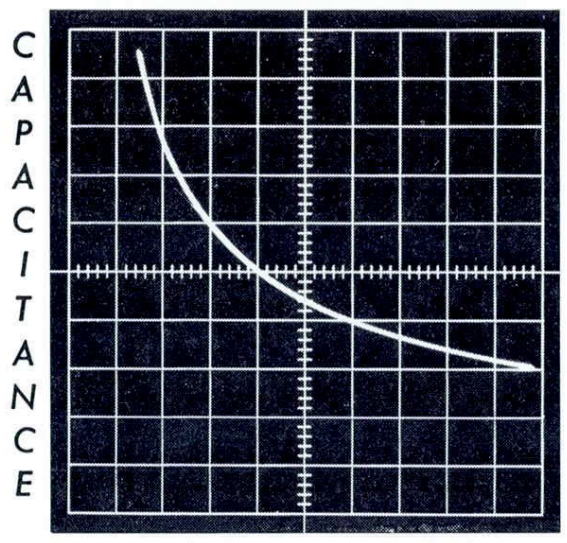
EQUIVALENT DC SENSITIVITY
A comparable DC amplification system would require a deflection factor of approx 10 μV/div for the same amount of power applied to the input bridge.

CAPACITIVE TRANSDUCERS
Use in conjunction with a four-arm resistive bridge results in the following maximum useful deflection capabilities: 120-ohm bridge (available internally), 1 pF/div; 1000-ohm bridge, 0.2 pF/div; useful deflection capabilities are slightly lower when using long cables.

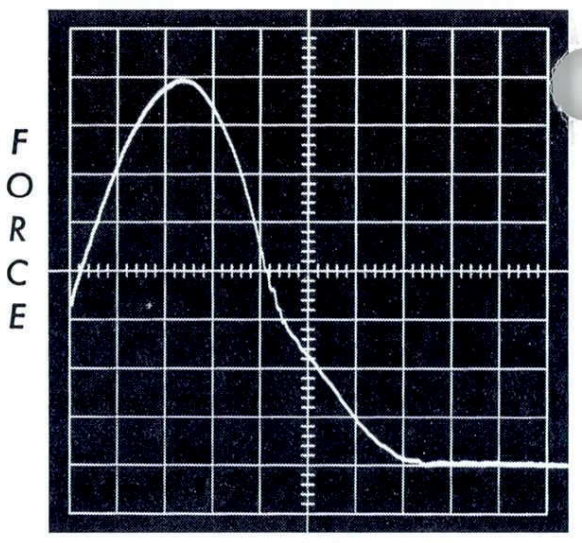
INDUCTIVE TRANSDUCERS
Must have characteristics compatible with the 25-kHz carrier frequency to function properly. Linear-variable-differential transformers designed for nominal carrier frequencies of 2 kHz and higher usually operate satisfactorily without additional circuitry.

Q Transducer & Strain-Gage Amplifier Q

Dynamic plot of the depletion-layer capacitance of a back-biased diode.



Pressing force can be accurately controlled by using the Type Q Unit.



TRANSDUCER CABLE

Either 3-wire or 4-wire shielded microphone cable gives the best results in most applications.

CAPACITANCE BRIDGE BALANCE

A vernier control allows compensation for an unbalance of up to 250 pF across any external resistive arm of the input bridge.

RESISTANCE BRIDGE BALANCE

A vernier control provides sufficient range to compensate for most standard transducers and strain gages.

GAGE RESISTANCE RANGE

Useful with cable lengths to 100 feet; extends from approximately 50 ohms to 2000 ohms. For optimum performance, the recommended range is between 120 and 500 Ω.

PHASE ADJUSTMENT

Permits either resistive or reactive transducer applications to be displayed.

CALIBRATION SWITCH

A rotary switch connects a calibration resistor across the strain gage to electrically simulate an external mechanical strain. The calibration resistor supplied with the Type Q Unit simulates a —400 microstrain unbalance of the bridge and is suitable for most strain gage applications. The calibration resistor is mounted on a handy plug-in receptacle. No special gage dial is nesessary for the unit.

To aid in calibration, a nomograph is included in the instruction manual. This nomograph relates calibration of the supplied resistor to gage factors and strain gage resistances. To include the gage factor in the calibration, merely increase or decrease the amplifier gain proportionally.

WEIGHTS

Net weight	5¼ lb	2.4 k
Domestic shipping weight	≈ 9 lb	≈4.1 k
Export-packed weight	≈14 lb	≈6.4 kg

INCLUDED STANDARD ACCESSORIES

4-wire 15-ft shielded connector cable (012-0040-00); two instruction manuals (070-0199-00).

TYPE Q PLUG-IN UNIT $400

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

350-ps Sampling Amplifier

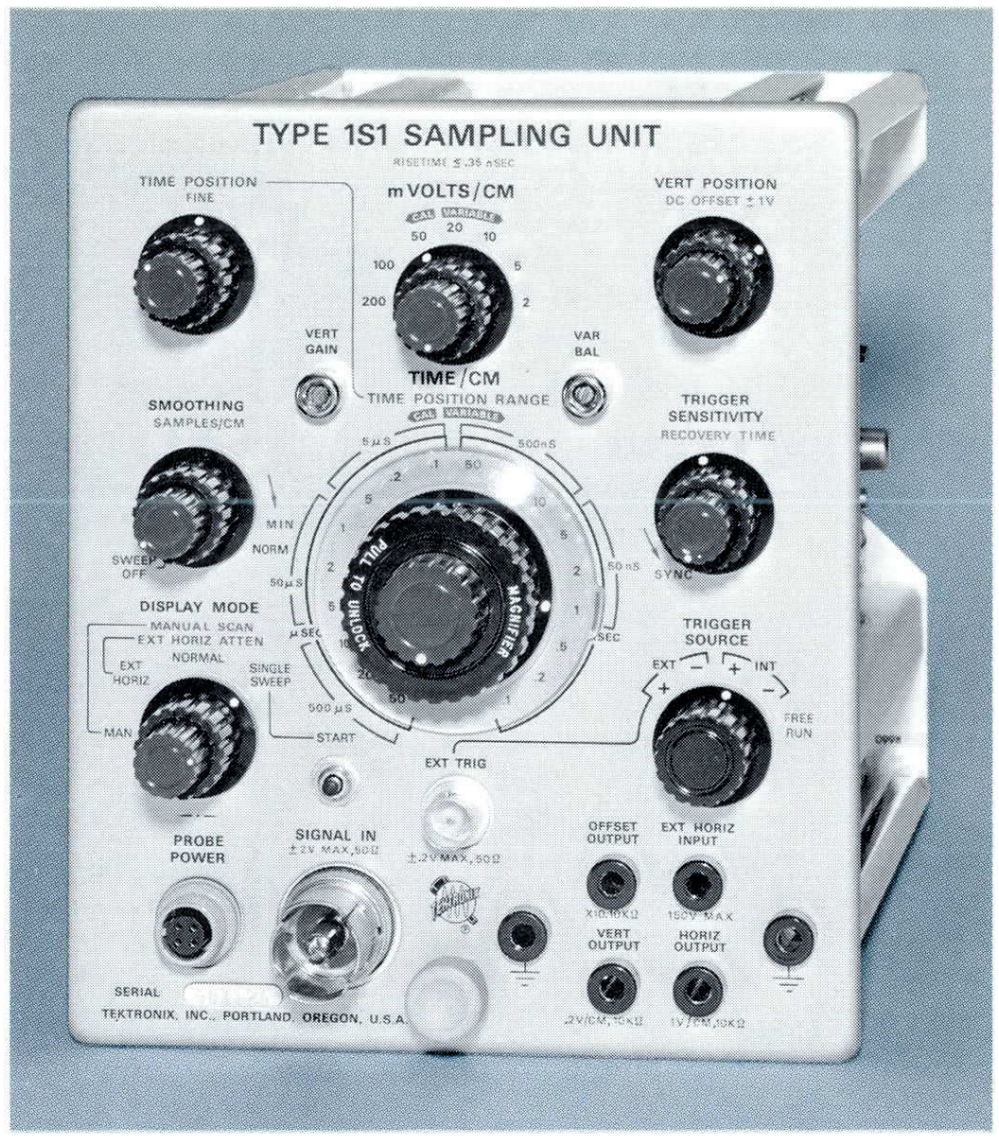
1S1

- ***DC-to-1 GHz BANDWIDTH***
- ***2 mV/cm-to-200 mV/cm DEFLECTION FACTOR***
- ***INTERNAL TRIGGERING***
- ***100 ps/cm-to-50 μs/cm CALIBRATED TIME BASE***

Used with any of the Type 530, 540, 550 or 580*-Series Oscilloscopes, the Type 1S1 Sampling Unit extends the measuring capabilities to 1 gigahertz. Operation is like a conventional oscilloscope—but with a combination of bandwidth and sensitivity possible only through sampling.

The Type 1S1 features internal triggering with a built-in delay line—no need for pretriggers or external delay lines. The tunnel-diode trigger circuit assures stable triggering through 1 gigahertz. Calibrated sweep range is from 100 ps/cm to 50 μs/cm. A single control is used to select the sweep range and magnify the display up to X100 when desired. This single-control feature allows direct read-out of the sweep time/cm even when magnified.

Calibrated vertical deflection factors range from 2 mV/cm to 200 mV/cm. Noise in the display is less than 1 mV, and can be reduced by a smoothing control. A DC-offset control permits observation of millivolt signals in the presence of up to ±1 volt input levels. Output signals are available at the front panel for driving chart recorders.



VERTICAL SYSTEM

RISETIME
Less than or equal to 350 ps.

BANDWIDTH
Equivalent to DC-to-1 GHz at 3-dB down.

DEFLECTION FACTOR
2 mV/cm to 200 mV/cm in 7 calibrated steps, 1-2-5 sequence. Each step accurate within 3%. Variable between steps, extending to 500 μV/cm, uncalibrated.

DISPLAYED NOISE
1mV or less unsmoothed; 500 μV, smoothed (includes 90% of dots).

INPUT CHARACTERISTICS
Nominally 50 Ω. Safe overload is ±5 V. GR874 input connectors. Trigger input is BNC, nominally 50 Ω.

DC OFFSET RANGE
+1 V to −1 V. Allows signals between +1 V and −1 V limits to be displayed at 2 mV/cm. Signals between +2 V and −2 V limits may be displayed at 200 mV/cm. Monitor jacks provide 10X actual DC offset through 10 kΩ.

VERTICAL OUTPUT
200 mV for each centimeter of displayed signal through 10 kΩ.

PROBE POWER
Available at front-panel connector for cathode-follower probe, Type 281 TDR Pulser, and Type 282 Adapter for high-impedance probes.

*A Type 81A Adapter is required.

HORIZONTAL SYSTEM

TIME BASE
50 μs/cm to 100 ps/cm in 18 calibrated steps, 1-2-5 sequence. Each step accurate within 3%. Variable between steps.

MAGNIFIER
Displays at sweep rates from 1 ns/cm to 50 μs/cm can be magnified up to X100 (depending on sweep rate) while maintaining a constant number of samples/cm and the same Time Position Range. Magnification occurs from a fixed time-reference point at the left end of the trace.

TIME POSITION RANGE
500 μs, 50 μs, 5 μs, 500 ns and 50 ns, depending on unmagnified TIME/CM setting. Coarse and fine TIME POSITION controls position start of the display through a time interval equal to the TIME POSITION RANGE setting.

SAMPLES/CM
Continuously variable adjustment of samples displayed per centimeter horizontally from approximately 5 samples/cm to an immeasurable number. Allows optimum adjustment of display rate and dot density.

DISPLAY MODES
Repetitive, single display, manual scan, or external scan. Front-panel START button for single-display operation.

INTERNAL DELAY LINE
Permits viewing the leading edge of the input waveform.

TRIGGERING

SOURCE (AC-Coupled): Internal, trigger pickoff in signal channel delivers approximately 1/7 of the input signal amplitude; External, 50-Ω terminated input. AMPLITUDE (EXT): Sinewaves, 10 mV to 400 mV, peak-to-peak; Pulses, 5 mV, either polarity. 2 V max DC. REPETITION RATE: Sinewave triggering or synchronizing from 100 kHz through 1 GHz. Pulse triggering from 10 Hz through 1 GHz. JITTER: Depends on signal shape, repetition rate and amplitude; ≤40 ps under optimum conditions.

HORIZONTAL OUTPUT

1 V per displayed centimeter; 10 kΩ source impedance.

WEIGHTS

Net weight	7¾ lb	3.5 kg
Domestic shipping weight	≈17 lb	≈ 7.7 kg
Export-packed weight	≈25 lb	≈11.4 kg

INCLUDED STANDARD ACCESSORIES

5-ns 50-Ω RG58 cable, GR connectors (017-0512-00); 50-Ω 42-inch BNC coaxial cable (012-0057-01); 10X 50-Ω GR attenuator (017-0078-00); 10X 50-Ω attenuator, BNC connectors (011-0059-01); 18-inch patch cord, banana connectors (012-0039-00); 18-inch patch cord, BNC-banana plugs (012-0090-00); GR-to-BNC female adapter (017-0063-00); GR-to-[illegible] male adapter (017-0064-00); two instruction manuals ([illegible]-0475-00).

TYPE 1S1 SAMPLING UNIT **$1400**

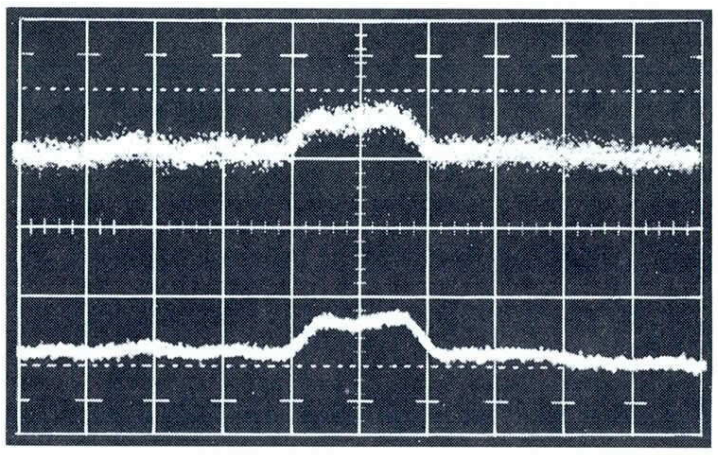
OPTIONAL ACCESSORIES

TYPE 281 TDR PULSER, order 015-0060-00	$95
TYPE 282 PROBE ADAPTER, order 015-0074-00	$95
P6034 10X Probe, order 010-0110-00	$44
P6035 100X Probe, order 010-0111-00	$44
P6040/CT-1 CURRENT PROBE, order 015-0041-00	$40
VP-1 VOLTAGE PICKOFF "T", order 017-0073-01	$28
POWER DIVIDER GR 874-TPD, order 017-0082-00	$77
COUPLING CAPACITOR, GR 874-K, order 017-0028-00	$12

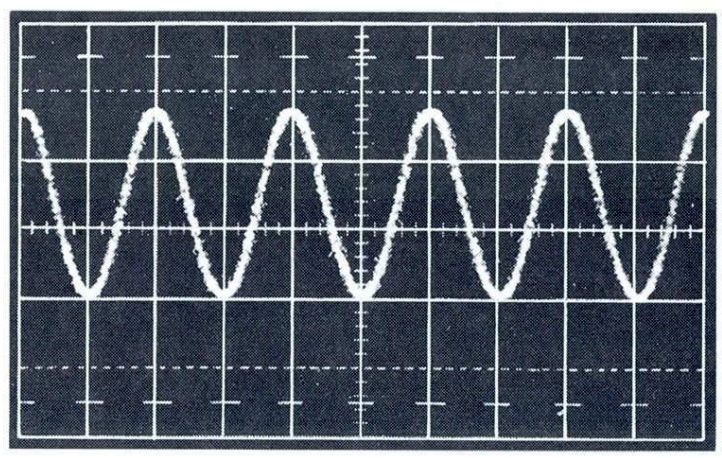
This represents only a partial listing of the many useful items available for sampling systems. Please refer to the catalog accessory section for a more complete listing.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

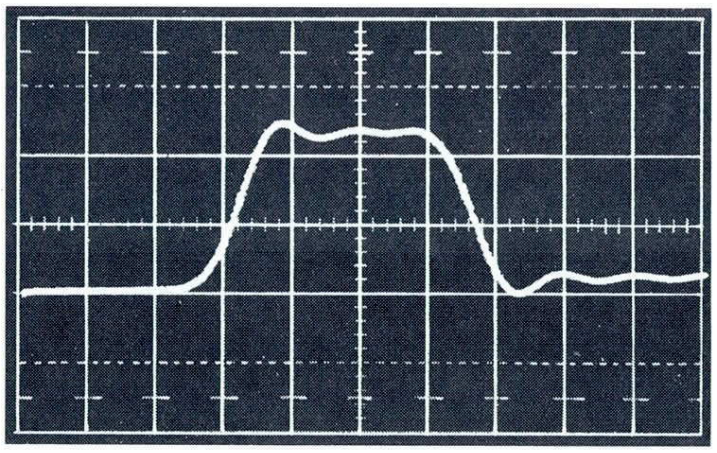
THE WAVEFORM PHOTOGRAPHS BELOW ILLUSTRATE THE PERFORMANCE CAPABILITIES OF THE TYPE 1S1 SAMPLING UNIT. THESE INCLUDE LOW INHERENT DISPLAY NOISE, STABLE TRIGGERING AND REAL-TIME SAMPLING.



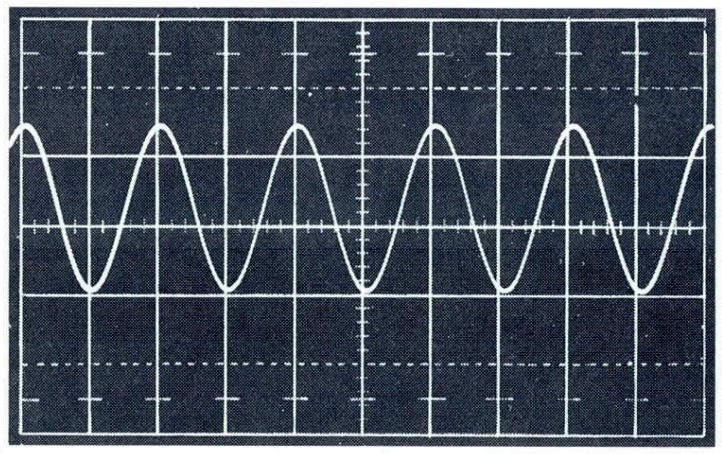
TANGENTIAL NOISE—A 1-mV, 2-ns wide pulse externally triggered. Upper waveform is unsmoothed. The lower is smoothed. Vert: 2 mV/cm. Horiz: 1 ns/cm.



TRIGGERING AT 1 GHz—A 1-GHz sinewave; internally triggered. Vert: 100 mV/cm. Horiz: 0.5 ns/cm.



PULSE TRIGGERING—A 50-mV, 2-ns wide pulse; internally triggered. Vert: 20 mV/cm. Horiz: 0.5 ns/cm.



REAL-TIME SAMPLING DISPLAY—A 1-kHz sinewave; Internal Main Frame triggering. Vert: 100 mV/cm (free running sampler). Horiz: 0.5 ms/cm (realtime—main frame).

Reflectometer & Sampling Unit

1S2

- ***140-ps TDR SYSTEM RISETIME***
- ***90-ps SAMPLING RISETIME***
- ***RHO AND VOLTAGE CALIBRATION***
- ***TWO INTERNAL PULSE SOURCES***

The Type 1S2 Sampling Plug-In converts any Tektronix 530, 540, or 550-Series Oscilloscope to a time-domain reflectometry measurement system. As a TDR, the Type 1S2 has a system risetime of 140 ps and is calibrated in rho (ρ) from 0.005 ρ/div to 0.5 ρ/div. The horizontal is calibrated from 1 cm/div to 100 m/div for dielectrics of air, TFE and polyethylene. Two pulse outputs provide either 50 ps t_r, 250 mV into 50 Ω, or 1 ns t_r, 1 V into 50 Ω.

The 90-ps risetime, 5-mV/div deflection factor, 100-ps/div sweep and built-in triggering capability make the Type 1S2 useful for many other sampling measurements. A pretrigger is required.

SYSTEM PERFORMANCE AS REFLECTOMETER

VERTICAL

SYSTEM RISETIME
Less than or equal to 140 ps, for the displayed reflection from a short-circuited 20-cm air line.

VERTICAL SCALE
Calibrated in ρ (rho) and volts: 0.005 ρ/div to 0.5 ρ/div or 5 mV/div to 500 mV/div in 7 calibrated steps (1-2-5 sequence), accurate within 3%. Continuous variation between steps, uncalibrated.

RESOLUTION
Reflection coefficients as small as 0.001 can be observed.

INPUT CHARACTERISTICS
Nominal 50-Ω feed-through signal channel, (termination supplied). GR874 connectors.

DC OFFSET RANGE
+2 ρ to −2 ρ (or +2 V to −2 V). Allows open-circuit reflections to be displayed at full sensitivity. Actual DC offset may be monitored at 1 ρ/V through 10 kΩ.

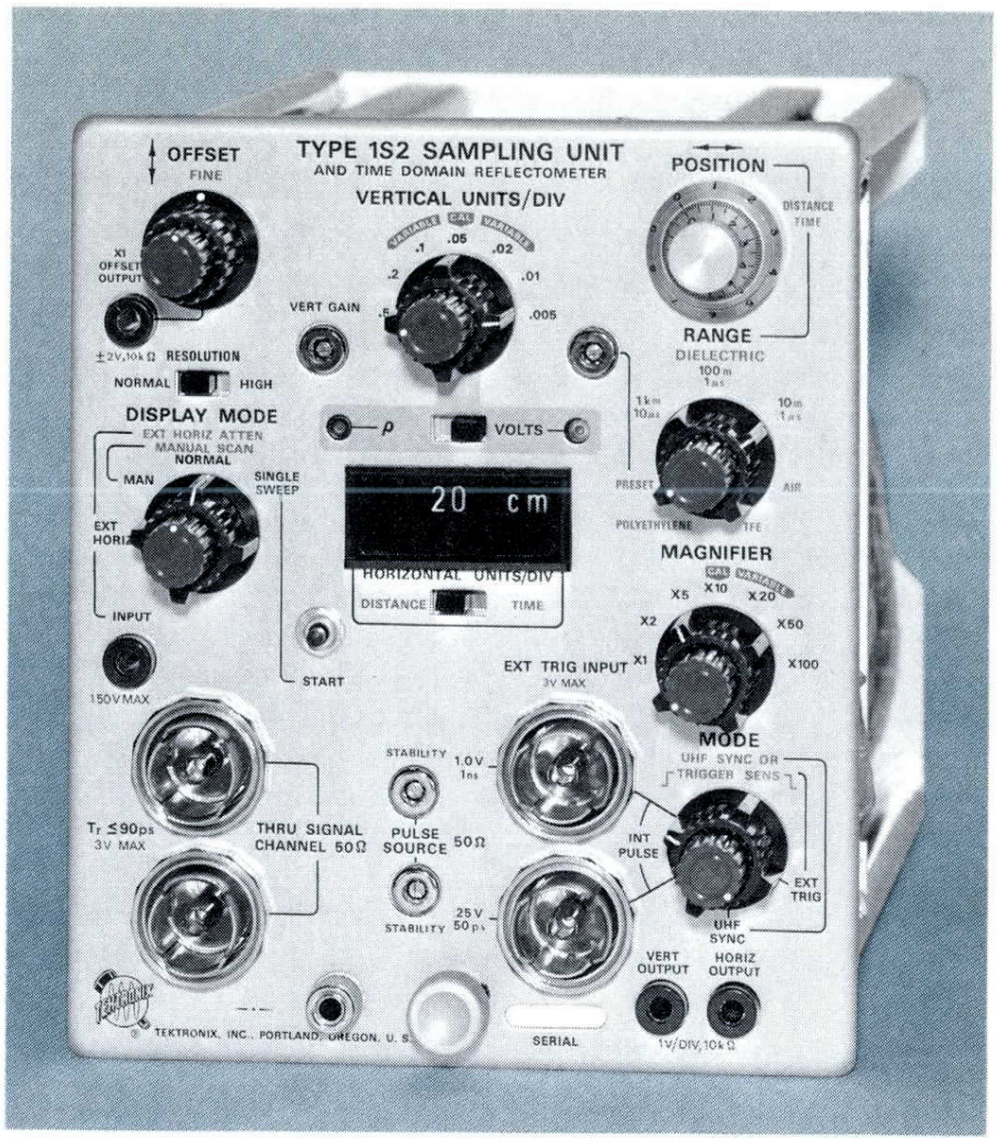
VERTICAL OUTPUT
1 V for each division of displayed signal through 10 kΩ.

HORIZONTAL

HORIZONTAL SCALE
Calibrated in distance and time: full-scale, 10-div display (without magnification) of 10 m, 100 m, or 1 km; 100 ns, 1 μs, or 10 μs. Accuracy is ±3% with or without magnification.

MAGNIFIER
X1 to X100 in 7 calibrated steps (1-2-5 sequence). Continuously variable between steps. Allows display to be magnified from a fixed on-screen reference point, 1 major division from the left edge of the graticule.

UNITS/DIV READOUT
Horizontal scale factor (combination of horizontal range and magnification settings) readout, directly at front panel, indicates either distance or time/div.



DISTANCE OR TIME POSITION
Ten-turn dial directly reads one-way distance or round-trip time to test-line discontinuity. Round-trip time readings are accurate to within ±1%. Range of 10-turn dial is the same as the full-scale, 10-div display without magnification.

JITTER
Less than or equal to 20 ps with internal pulse sources.

DIELECTRIC
Calibrated for air, tfe and polyethylene lines. Preset mode adjustable for lines with velocity of propagation from 0.6 to 1.0X velocity of light.

DISPLAY MODES
Repetitive or single sweep, manual or external scan.

HORIZONTAL OUTPUT
1 V for each division of displayed signal through 10 kΩ.

PULSE SOURCES

FAST-RISE OUTPUT
Approximately 50-ps risetime, 250 mV. 50-Ω source (reverse terminated).

LARGE-AMPLITUDE OUTPUT
Approximately 1-ns risetime, 1 V. 50-Ω source (reverse terminated).

PERFORMANCE AS SAMPLER

RISETIME
Less than or equal to 90 ps.

BANDWIDTH
Equivalent to DC-to-3.9 GHz at 3-dB down.

1S2 Reflectometer & Sampling Unit

1S2

DEFLECTION FACTOR

5 mV/div to 500 mV/div in 7 calibrated steps, 1-2-5 sequence, accurate within 3%. Continuous variation between steps, uncalibrated.

RANDOM NOISE

Equivalent to an input signal of 2 mV or less (tangentially-measured).

SIGNAL RANGE

Signals between +2 V and —2 V limits may be displayed at any deflection-factor setting. Safe overload is ±3 V if signal channel is coupled directly into EXT TRIG INPUT, ±5 V if not.

TRIGGERING

SOURCE: External only, AC coupled—may serve as termination for signal channel. AMPLITUDE: Sinewaves, 100 mV to 2 V, peak-to-peak; Pulses, 50 mV to 1 V either polarity. 3 V max DC. REPETITION RATE: Sinewave triggering or synchronizing from 100 kHz through 5 GHz. Pulse triggering from 10 Hz through 5 GHz. JITTER: Depends on signal shape, repetition rate and amplitude; ≤30 ps under optimum conditions.

WEIGHTS

Net weight	8 lb	3.3 k
Domestic shipping weight	≈18 lb	≈ 8.2
Export-packed weight	≈28 lb	≈12.7 kg

INCLUDED STANDARD ACCESSORIES

10-inch GR cable (017-0513-00); 5X attenuator (017-0079-00); 2X attenuator (017-0080-00); 50-Ω termination (017-0081-00); 20-cm air line (017-0084-00); 50-Ω termination, short circuit (017-0087-00); 5-ns, 50-Ω RG213 cable (017-0502-00); 18-inch patch cord (012-0039-00); 18-inch BNC-to-banana plug patch cord (012-0090-00); two instruction manuals (070-0889-00).

TYPE 1S2 SAMPLING UNIT $1525

OPTIONAL ACCESSORIES

P6034 10X Probe Package, order 010-0110-00 ..... $ 44
P6035 100X Probe Package, order 010-0111-00 ..... $ 44
Power Divider, GR 874-TPD, order 017-0082-00 ..... $ 77
Coupling Capacitor, GR 874-K, order 017-0028-00 .... $ 12

This listing covers only a few of the more commonly useful items for sampling instruments. A more complete listing can be found in the accessory section of this catalog.

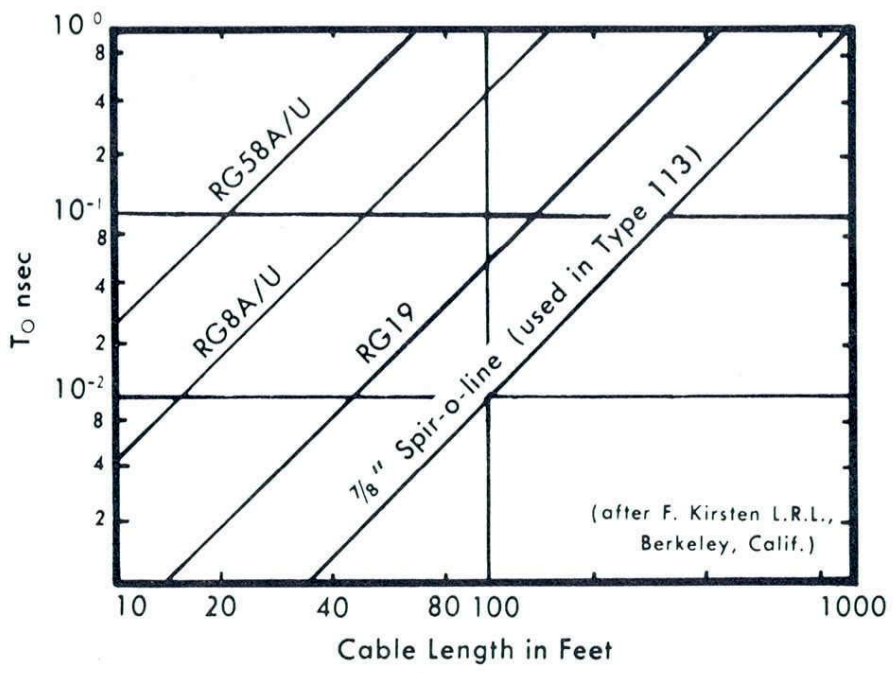
113 Delay Cable

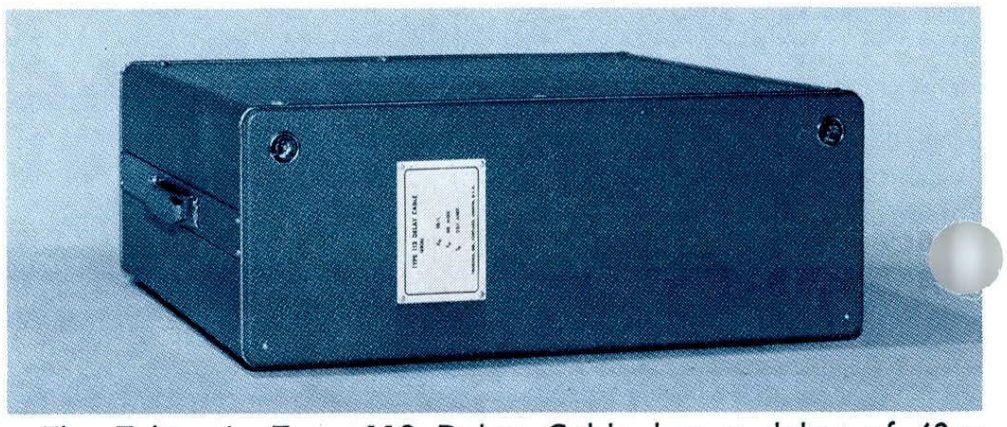
113

Transmission Lines

Transmission line distortion of a step function shows up in a distinctive way. After a small transition period, the output rises fairly rapidly and then slows considerably, compared to an RC charge. An RC step requires 2.2 time constants to change from 10% to 90% of the input step. A transmission line requires 30 times the 0-to-50% risetime period to accomplish this (10% to 90%) transition.

The graph illustrates time of rise from 0-to-50% (T_o) of the input for various common coaxial cables. Note that the risetime deteriorates as the square of the length. Thus, it is very important to keep cable lengths (or delays) to a minimum. The Type 113 uses about 50 feet of 7/8-inch diameter cable, resulting in a 10% to 90% risetime of better than 0.1 nanosecond.





The Tektronix Type 113 Delay Cable has a delay of 60 ns and a characteristic impedance of 50 Ω. In general it is used in those sampling applications where the vertical amplifier does not contain internal delay lines and the triggering of the sweep is external and signal delay is required.

CHARACTERISTIC IMPEDANCE

50 Ω ±1%.

HIGH QUALITY CABLE

Approximately 1.5-dB loss per 100 feet at 1000 MHz. Risetime approximately 0.1 ns.

DIMENSIONS AND WEIGHTS

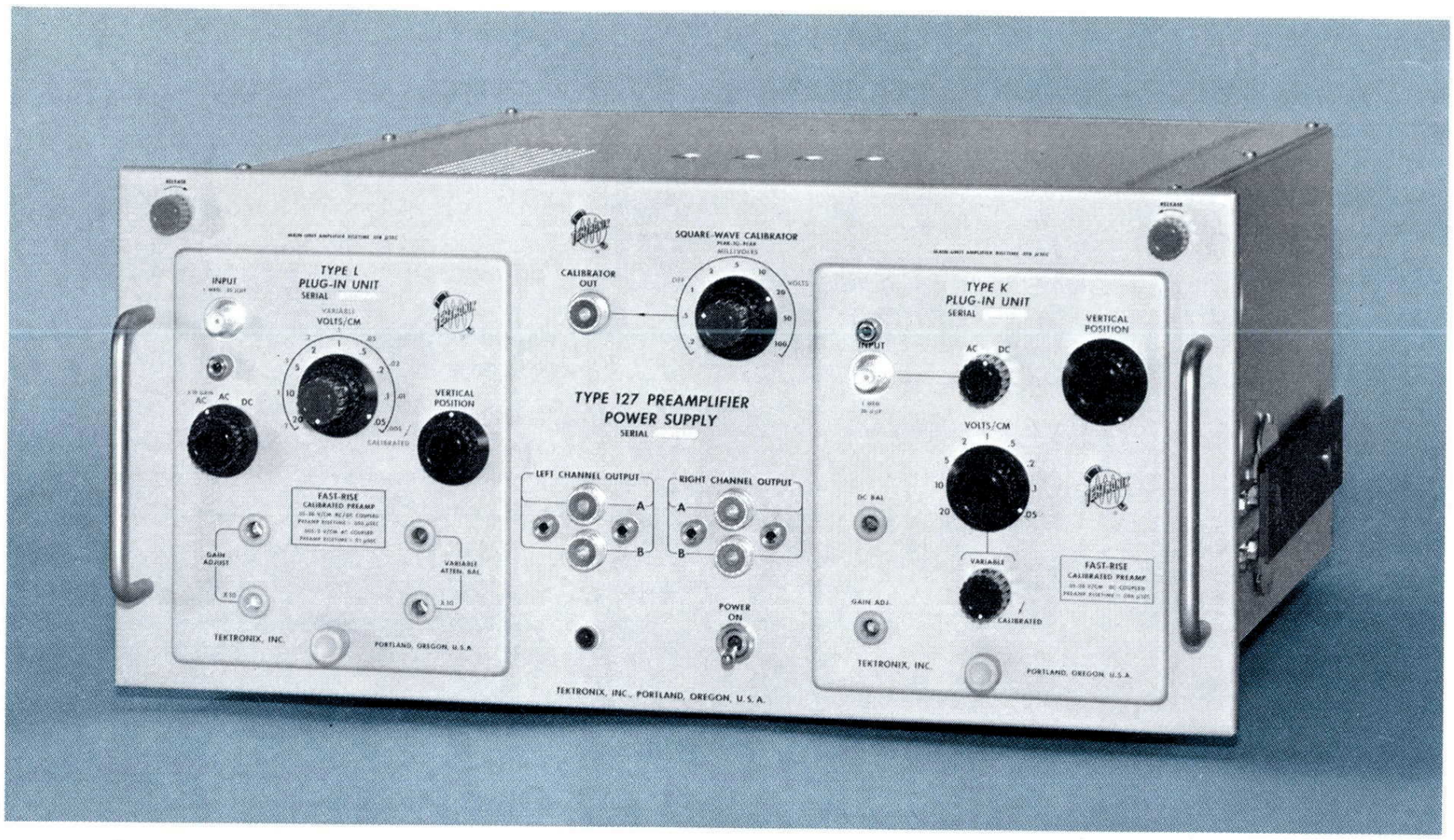
Height	22 3/8 in	57.1 cm
Width	8 5/8 in	21.9 cm
Depth	21 7/8 in	55.5 cm
Net weight	44 3/4 lb	20.3 kg
Domestic shipping weight	≈60 lb	≈27.3 kg
Export-packed weight	≈75 lb	≈34.1 kg

TYPE 113 DELAY CABLE $310

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Power Supply for Plug-In Units

127



ACCEPTS MULTI-TRACE, DIFFERENTIAL, SPECTRUM ANALYZER, AND SAMPLING, PLUG-IN UNITS

- **DC-to-19 MHz BANDWIDTH**

The Tektronix Type 127 Preamplifier Power Supply provides operating power to one or any combination of two Tektronix Letter Series or "1" Series Plug-In Units. This permits the operation of Tektronix Plug-Ins separate from the oscilloscope in which they are normally used. For example, a double-differential dual-trace display can be obtained with a Type 127 and two Type 1A5, 1A6 or 1A7A Plug-In Units—when used in conjunction with a dual-trace oscilloscope.

Triggering Signal Inputs are provided at the rear of the instrument to permit the introduction of triggering pulses into a Type 1A1, 1A2 or 1A4 Unit to utilize the alternate-sweep features of these multitrace units. The triggering pulses may be obtained from the + GATE OUT terminal of the associated oscilloscope.

Spectrum Analyzer Units require an external sweep voltage (positive going from 0 to at least +90 V). This can be supplied from a Type T Time Base Unit in one compartment, or from an associated oscilloscope with this signal output.

CHARACTERISTICS

BALANCED OUTPUT

The outputs of Plug-In Units powered by the Type 127 are fed through DC-coupled differential amplifier stages and cathode followers to provide a push-pull signal at the output terminals. Push-pull output swing is linear ±3% over a range of ±0.3 volt into 170-Ω termination. Output DC operating levels are adjustable to ground potential.

GAIN

The Type 127 has a gain of one, push-pull. With single-ended output, gain is one-half.

OUTPUT TERMINALS

Each channel has four output terminals, two on the front panel and two at the rear. Terminated 170-Ω output cables are furnished.

AMPLITUDE CALIBRATOR

A squarewave calibration voltage is available through a front-panel coaxial connector. Eighteen fixed voltages—0.2 mV to 100 V, peak to peak (1, 2, 5 sequence). Accuracy is within 3%. Squarewave frequency is approximately 1 kHz.

Power Supply for Plug-In Units

127

TYPE 127 TYPICAL PERFORMANCE†			
PLUG-IN UNIT	MAXIMUM VOLTAGE GAIN	BANDWIDTH (—3 dB)	RISE-TIME
L	2 20	DC to 19 MHz 3 Hz to 17 MHz	19 ns 21 ns
O	2	DC to 17 MHz	21 ns
Q	*	DC to 6 kHz	60 μs
W	2 100	DC to 16 MHz DC to 7.5 MHz	22 ns 47 ns
1A1	2 20 200	DC to 19 MHz DC to 17 MHz 2 Hz to 11 MHz	19 ns 21 ns 32 ns
1A2	2	DC to 19 MHz	19 ns
1A4	10	DC to 19 MHz	19 ns
1A5	20 100	DC to 19 MHz DC to 18 MHz	19 ns 20 ns
1A6	100	DC to 2 MHz	0.18 μs
1A7A	10,000	DC to 1 MHz	0.35 μs
1L5	100	10 Hz to 1 MHz	0.35 μs
1L10	NA**	1 MHz to 36 MHz	NA**
1L20	NA**	10 MHz to 4.2 GHz	NA**
1L40	NA**	1.5 GHz to 40 GHz	NA**
1S1	50	Equiv to DC to 1 GHz	0.35 ns
1S2	20	Equiv to DC to 3.9 GHz	90 ps

*A 10 μstrain input produces a 100-mV output.

**Not applicable.

†Push-pull output terminated in 170 Ω, monitored with DC-to-33 MHz oscilloscope.

POWER REQUIREMENT

105 V to 125 V or 210 V to 250 V, 50 to 60 Hz, 450 watts maximum. Unit factory wired for 117 V. Can be factory wired for 234 V if so indicated on order.

DIMENSIONS AND WEIGHTS

Height	8¾ in	22.3 cm
Width	19 in	48.3 cm
Depth	21⅝ in	55.0 cm
Net weight	37¼ lb	16.9 kg
Domestic shipping weight	≈71 lb	≈32.3 kg
Export-packed weight	≈92 lb	≈41.9 kg

RACKMOUNTING

Type 127 can be withdrawn from rack on slide-out tracks, tilted and locked in 4 positions. Further mounting information on catalog instrument dimension page.

INCLUDED STANDARD ACCESSORIES

Four 170-Ω terminations (011-0048-00); four 170-Ω coaxial cables (012-0034-00); four BNC-to-UHF adapters (103-0032-00); four UHF-to-BNC adapters (103-0015-00); 3-conductor power cord (161-0010-03); 3 to 2-wire adapter (103-0013-00); pair mounting tracks (351-0085-00); two instruction manuals (070-0284-00).

TYPE 127 POWER SUPPLY, without plug-in units . . **$775**

CRADLE ASSEMBLY

For rear slide support when the instrument is to be mounted in a backless rack, includes necessary mounting hardware, order 040-0344-00 . . . . . .

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Power Supply for Plug-In Units

132

- ***ACCEPTS MULTI-TRACE, DIFFERENTIAL, SPECTRUM ANALYZER, AND SAMPLING PLUG-IN UNITS***

- ***DC-to-16 MHz BANDWIDTH***

The Type 132 provides an electronically regulated power supply and amplifier for any Tektronix Letter-Series or "1" Series Plug-In Unit.

Convenient front-panel terminals for either push-pull or single-ended output facilitate connections to associated equipment.

CHARACTERISTICS

BANDWIDTH

DC to 16 MHz at 3-dB down, depending on plug-in unit and load impedance. See chart.

GAIN

10 (push-pull) when using a Tektronix Plug-In Unit at 50-mV/cm deflection factor, terminated with a 93-Ω load (approximately 5 into 50-Ω load).

OUTPUT

Push-pull, or single-ended + or — outputs on front panel.

OUTPUT VOLTAGE

Source impedance is ≈5 kΩ with ±10 mA available short circuited. With 93-Ω load, voltage swing is ≈±1 V max. No load, voltage is ±50 V single ended or ±100 V push-pull.

DUAL-TRACE OPERATION

Back-panel jacks and switching arrangements provide for use of the alternate and chopped modes of operation including blanking, with a Tektronix Multi-Trace Plug-In Unit (1A1, 1A2 or 1A4).

POWER REQUIREMENTS

Wired for 105 to 125 VAC (117 V nominal); transformer taps permit operation at 110, 117, 124, 220, 234, or 248 VAC; 50 to 60 Hz. Approx 320-W power consumption. Can be factory wired for any of the above nominal voltages, if so indicated on order.

DIMENSIONS AND WEIGHTS

Height	$10\frac{3}{16}$ in	25.9 cm
Width	$6\frac{7}{8}$ in	17.5 cm
Depth	$18\frac{15}{16}$ in	48.1 cm
Net weight	21 lb	9.5 kg
Domestic shipping weight	≈26 lb	≈11.8 kg
Export-packed weight	≈33 lb	≈15.0 kg

INCLUDED STANDARD ACCESSORIES

Two 93-Ω terminations (011-0056-00); two 93-Ω cables (012-0075-00); 3-conductor power cord (161-0010-03); 3 to 2-wire adapter (103-0013-00); two instruction manuals (070-0288-01).

TYPE 132 POWER SUPPLY, without plug-in units . . . $545

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

TYPE 132 TYPICAL PERFORMANCE†

PLUG-IN TYPE	TERMINATED IN 93 Ω		DOUBLE TERMINATED 93 Ω	
	SYSTEM GAIN‡	BANDWIDTH	SYSTEM GAIN‡	BANDWIDTH
L	100 10	14 MHz 14 MHz	50 5	16 MHz 16 MHz
O	10	14 MHz	5	16 MHz
Q		6 kHz		6 kHz
W	500 10	7 MHz 14 MHz	250 5	7 MHz 16 MHz
1A1	100	14 MHz	50	16 MHz
1A2	10	14 MHz	5	16 MHz
1A4	50	14 MHz	25	16 MHz
1A5	500 250	13 MHz 14 MHz	250 125	15 MHz 16 MHz
1A6	500	2 MHz	250	2 MHz
1A7A	Useful to 20,000	1 MHz	Useful to 10,000	1 MHz
1L5	500	1 MHz	250	1 MHz
	Spectrum Analyzer 10 Hz to 1 MHz			
1L10	Spectrum Analyzer 1 MHz to 36 MHz			
1L20	Spectrum Analyzer 10 MHz to 4.2 GHz			
1L40	Spectrum Analyzer 1.5 GHz to 40 GHz			
1S1	250	Equiv to 1 GHz	125	Equiv to 1 GHz
1S2	100	Equiv to 3.9 GHz	50	Equiv to 3.9 GHz

†Push-pull output, monitored with DC-to-24 MHz oscilloscope.

‡System Gain = Overall gain from input of plug-in to the push-pull output cables.

Spectrum Analyzer Units require an external sweep voltage (positive going from 0 to at least +90 V). This can be supplied from an associated oscilloscope with this output.

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TYPE 10A1, DC-TO-55 MHz DIFFERENTIAL UNIT	152
TYPE 10A2A, DC-TO-100 MHz DUAL-TRACE UNIT	154
TYPE 11B1, TIME-BASE UNIT	155
TYPE 11B2A, SWEEP DELAY TIME-BASE UNIT	156

REFERENCE INFORMATION

The Types 647A and R647A, with 10-Series and 11-Series Plug-in Units, comprise a complete high-performance system built to withstand operating and storage conditions far more severe than those found in the laboratory.

In addition to exceptional ruggedness, this system also provides the operational and display abilities needed for high accuracy laboratory requirements. These include:

Plug-in adaptability

Calibrated sweep delay

6 x 10-cm viewing area

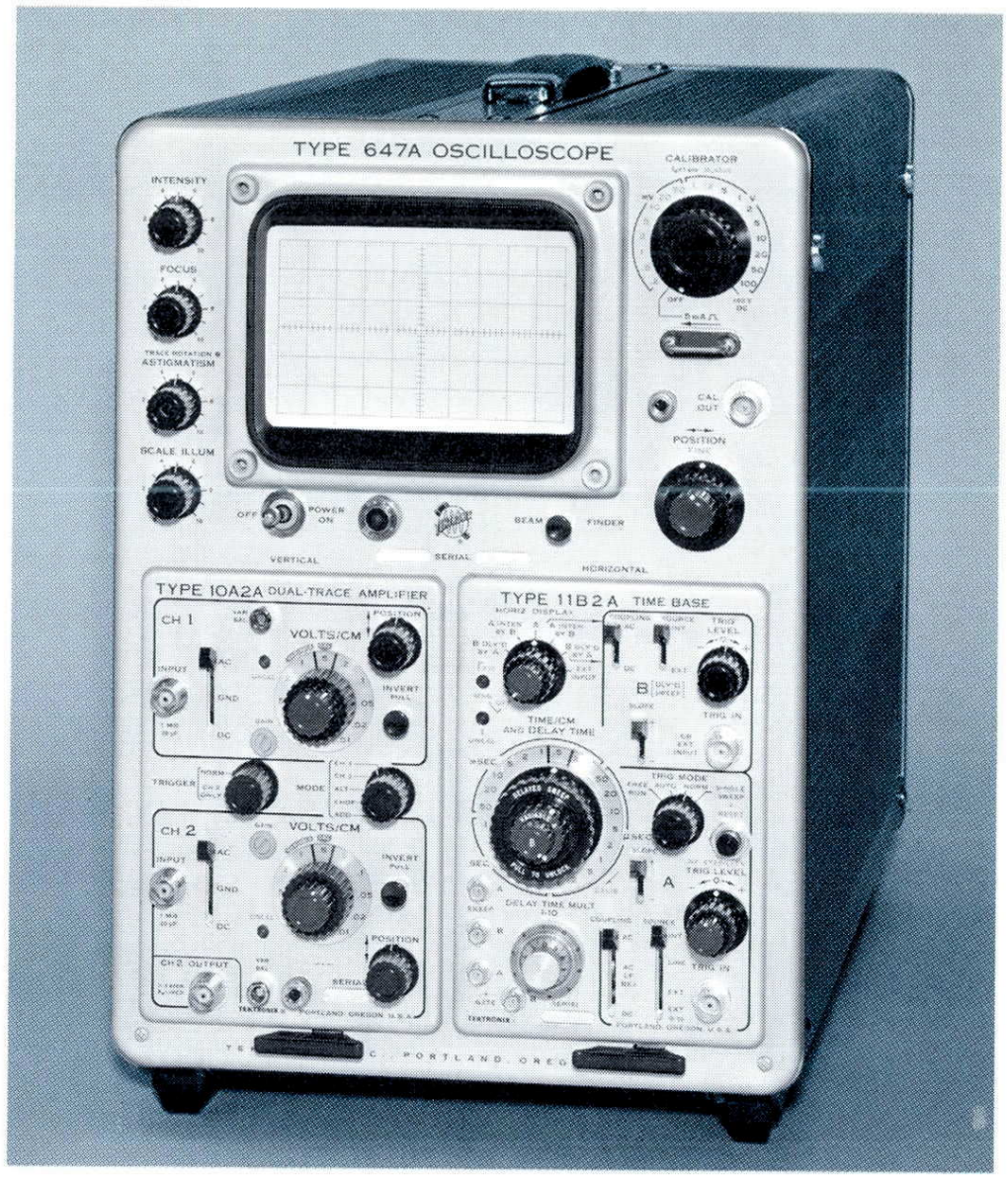
Internal, illuminated graticule

High photographic writing speed

This series of oscilloscopes provides the widest temperature operating range (—30° C to +65° C) presently available from Tektronix. This wide operating range allows operation in severe temperature environments with a margin of safety elsewhere unavailable.

The Types 10A1 Differential Unit (with slide-back voltage offset) and 10A2A Dual-Trace Unit afford plug-in versatility coupled with reliable, higher-than-normal accuracy performance. These vertical plug-in units provide the capability to meet all but very specialized measurement needs. If temperature operating range, vibration, altitude, shock, and humidity are considerations in YOUR selection of an oscilloscope, the 647A-Series represents excellent value in a versatile plug-in type package.

647A 100-MHz Ruggedized Oscilloscope R647A



- ***DC-to-100 MHz BANDWIDTH WITH OR WITHOUT PROBES***
- ***BUILT FOR SEVERE ENVIRONMENTS***
- ***HIGH WRITING SPEED***
- ***ILLUMINATED NO-PARALLAX GRATICULE***
- ***6 x 10-cm DISPLAY***
- ***SOLID-STATE DESIGN***

The Type 647A and R647A are compact, high-performance instruments capable of accurate measurements over an ambient temperature range from —30° C to +65° C. Accuracy is even better in normal ambient temperatures ranging from 0° C to +40° C.

The Type 647A and R647A Oscilloscopes offer bandwidths from DC to 100 MHz with or without probes when used with the Type 10A2A Dual-Trace Plug-in Unit. Triggering over the entire 100-MHz bandwidth is possible with a Type 11B2A Sweep-Delay Time-Base Unit.

An accelerating potential of 14 kV provides a small, bright CRT spot with corresponding high writing speed. An internal, 6 x 10-cm graticule with variable illumination offers parallax-free measurements.

A quick-change line-voltage selector permits simple and convenient adaptation to 6 different line-voltage ranges.

CHARACTERISTIC SUMMARY

VERTICAL

Two vertical plug-in units are available: Type 10A1 Differential Amplifier featuring voltage-comparator capability, and Type 10A2A Dual-Trace Amplifier with 100-MHz bandwidth. Operating modes of Type 10A2A include CH 1, CH 2, ALTERNATE, CHOP (≈1-MHz rate), and ADD.

HORIZONTAL

Two time-base plug-in units are available: Type 11B1 with single time base and direct reading magnifier, and Type 11B2A with dual time bases and sweep delay; both units equipped with single sweep for photographic recording.

CRT

DISPLAY AREA—6 x 10 cm

ACCELERATING VOLTAGE—14 kV

PHOSPHOR—P31

OTHER

AMPLITUDE CALIBRATOR—0.2 mV to 100 V, 1-kHz square-wave.

POWER REQUIREMENT—90 V to 136 V and from 180 V to 272 V in six ranges; range selection accomplished by quick-change, switching device. Maximum power approx 200 watts at 115 V and 60 Hz. Type 647A: 45 to 440 Hz, Type R647A: 45 to 66 Hz.

647A 100-MHz Ruggedized Oscilloscope R647A

VERTICAL DEFLECTION

BANDWIDTH AND RISETIME

Bandwidth figures are at 3-dB down.

PLUG-IN	DEFLECTION FACTOR	BANDWIDTH*		RISETIME	
		0°C to +40°C	−30°C to +65°C	0°C to +40°C	−30°C to +65°C
10A1	5 mV/cm to 20 V/cm	55 MHz	50 MHz	6.4 ns	7 ns
	1 mV/cm and 2 mV/cm	35 MHz	35 MHz	10 ns	10 ns
10A2A	10 mV/cm to 20 V/cm	100 MHz	90 MHz	3.5 ns	3.9 ns

*Stated frequencies are upper bandwidth limits. Lower limit is DC (when DC coupled). With AC coupling, low-frequency 3-dB-down point is ≈ 1.6 Hz without probe, or ≈ 0.16 Hz with P6047 10X Probe.

SIGNAL DELAY

Permits observation of the leading edge of the waveform that triggers the sweep. Delay line requires no tuning.

HORIZONTAL DEFLECTION

Two Time-Base Plug-In Units are available for use with the Type 647A and R647A Oscilloscopes.

PLUG-IN UNIT	CALIBRATED RANGE	SWEEP MAGNIFIER	SWEEP SYSTEM
Type 11B1	0.1 μs/cm to 2 s/cm	Direct reading up to X50, 10 ns/cm max	Single Time Base Generator
Type 11B2A	0.1 μs/cm to 5 s/cm	X10, Extends Range to 10 ns/cm	Dual Time Base Generator with Sweep Delay

Both plug-in units have single-sweep and external-horizontal-amplifier capability.

CRT

TEKTRONIX CRT

Rectangular, flat-faced CRT. 14-kV accelerating potential for bright displays. P31 phosphor normally supplied, P11 is optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability.

GRATICULE

No-parallax, 6 x 10-cm, internal graticule with variable edge illumination. Ruled in 1-cm divisions, vertical and horizontal centerlines further marked in 2-mm increments.

EXTERNAL CRT INPUTS

Input through unblanking amplifier to CRT grid, usable from DC to 10 MHz; visible modulation with 4-V peak-to-peak signal. An additional input to CRT cathode is AC coupled; visible modulation with 5-V peak-to-peak signal.

ENVIRONMENTAL CAPABILITIES

AMBIENT TEMPERATURE

Operating: Type R647A: −30°C to +65°C.
Type 647A: −30°C to +65°C, continuous, when instrument is not tipped more than 20° in any direction from level position. When instrument is operated vertically (with front panel up), the maximum ambient temperature is +55°C. Non-operating: −55°C to +75°C.

VIBRATION*

Operating: 0.025 inch peak to peak, 10 to 55 to 10 c/s in 1 minute sweeps (4 g at 55 c/s) for 15 minutes on each axis.

ALTITUDE

Operating: 15,000 feet maximum. Maximum operating temperature of the Type 647A reduced to +55°C at 15,000 feet. Non-operating: 50,000 feet, maximum.

SHOCK

Non-operating: 20 G's, one-half sine, 11-millisecond duration. Two shocks each direction along each of the three major axes; total of 12 shocks.

HUMIDITY

Non-operating: Meets electrical performance specifications after exposure to five cycles (120 hours) of Mil-Std-202B, method 106A (omit freezing and vibration, and allow 24-hour post-test drying period before operating).

TRANSPORTATION

Meets National Safe Transit test when factory-packaged: Vibration for one hour at slightly greater than one G. Drop on any corner, edge or flat surface; 18-inch drop for Type R647A, 30-inch drop for Type 647A.

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR

0.2 mV to 100 V in 18 calibrated steps (1-2-5 sequence), 1-kHz squarewave. Crystal-controlled frequency accurate within 0.1% from −30° C to +65° C.

Output resistance 50 Ω from 0.2 mV to 0.2 V. Squarewave duty cycle 49.9% to 50.1%. Risetime ≤1 μs. For current-probe calibration, a 5-mA squarewave is available through a front-panel current loop. The calibrator also provides a 100-V DC output.

AMPLITUDE ACCURACY	0°C to +40°C	−30°C to +65°C
100 V and 100 mV	±1%	±1.5%
All other positions	±2%	±3%

POWER REQUIREMENTS

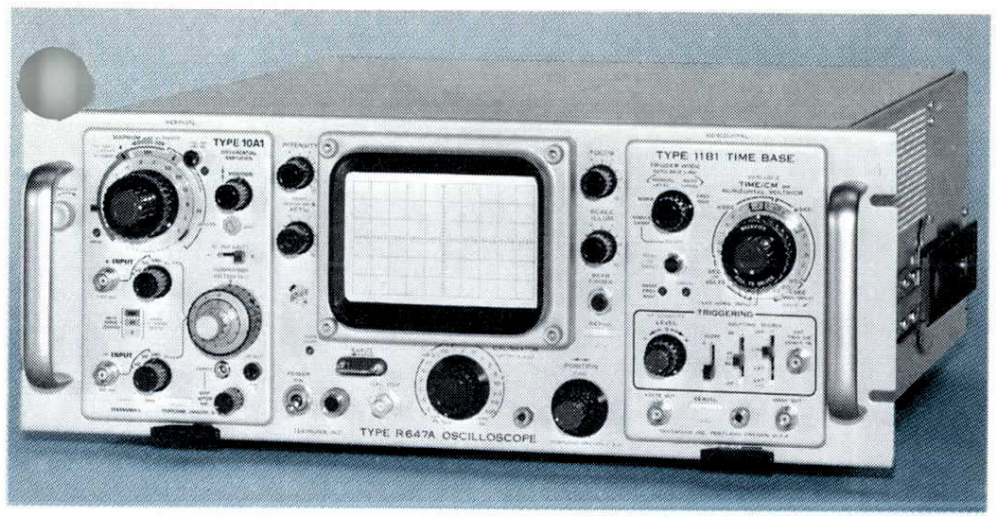
Quick-change line-voltage selector permits selection of the following ranges: 90 V to 110 V, 104 V to 126 V, 112 V to 136 V, 180 V to 220 V, 208 V to 252 V, or 224 V to 272 V. Approx 200 watts maximum at 115 V and 60 Hz. Type 647A: 45 to 440 Hz. Type R647A: 45 to 66 Hz.

TYPE 647A DIMENSIONS AND WEIGHTS

Height	14⅝ in	37.1 cm
Width	9⅞ in	25.2 cm
Depth	22 in	56.0 cm
Net weight	40 lb	17.8 kg
Domestic shipping weight	≈49 lb	≈21.9
Export-packed weight	≈62 lb	≈27.6

*Applicable to R647A when mounted in a rack with rear support kit 016-0065-00.

100-MHz Ruggedized Oscilloscope



TYPE R647A DIMENSIONS AND WEIGHTS

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Rack depth	19 in	48.3 cm
Net weight	50 lb	22.2 kg
Domestic shipping weight	≈73 lb	≈32.4 kg
Export-packed weight	≈96 lb	≈42.6 kg

INCLUDED STANDARD ACCESSORIES

Two P6047 Probes (010-0211-00); smoke-gray filter, installed (378-0548-00); 8-inch, 93-Ω cable, BNC to BNC (012-0123-00); clear implosion shield (337-0573-00); 18-inch patch cord, BNC to BNC (012-0087-00); 18-inch patch cord, BNC to banana plug (012-0091-00); BNC post jack (012-0092-00); 3 to 2-wire adapter (103-0013-00); 6-inch patch cord, BNC to BNC (012-0085-00); 2 red plastic graticule-light inserts (377-0105-00); Type 647A: two instruction manuals (070-0614-00); Type R647A: two instruction manuals (070-0627-00); set mounting tracks and hardware (351-0085-00); rackmount rear support kit (016-0065-00); hardware kit (016-0099-00).

TYPE 647A OSCILLOSCOPE, without Plug-In Units . **$1725**

TYPE R647A OSCILLOSCOPE, without Plug-In Units (45-to-66 Hz power source) **$1850**

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience. The standard probe supplied with the instrument satisfies most measurement requirements; optional probes, including high-voltage and current-measuring probes, may be better suited for particular applications. See catalog accessory pages for additional information on these and other items.

REAR-PANEL CONNECTOR

10-pin connector for remote single-sweep reset and external use of power-supply voltages. Order (131-0300-00) . . $14.50

C-27-662 R CAMERA

Equipped with a special lens to permit single-sweep photography of oscilloscope displays at fast writing speeds. 1:0.5, f/1.3 lens, Polaroid Land* Roll-Film back.

Order C-27-662 R $635

Mounting Adapter(order 016-0223-00 . . . . . $ 16

PROBES

P6023 10X Low-Capacitance Probe for use with Tektronix differential amplifiers.

Order P6023 PROBE PACKAGE (010-0167-00 LOCKING BNC) . . . . . $ 52

SCOPE-MOBILE® CART

Model 201-2: Storage drawer, carrier for two plug-in units, 9-position tilt-lock oscilloscope tray.

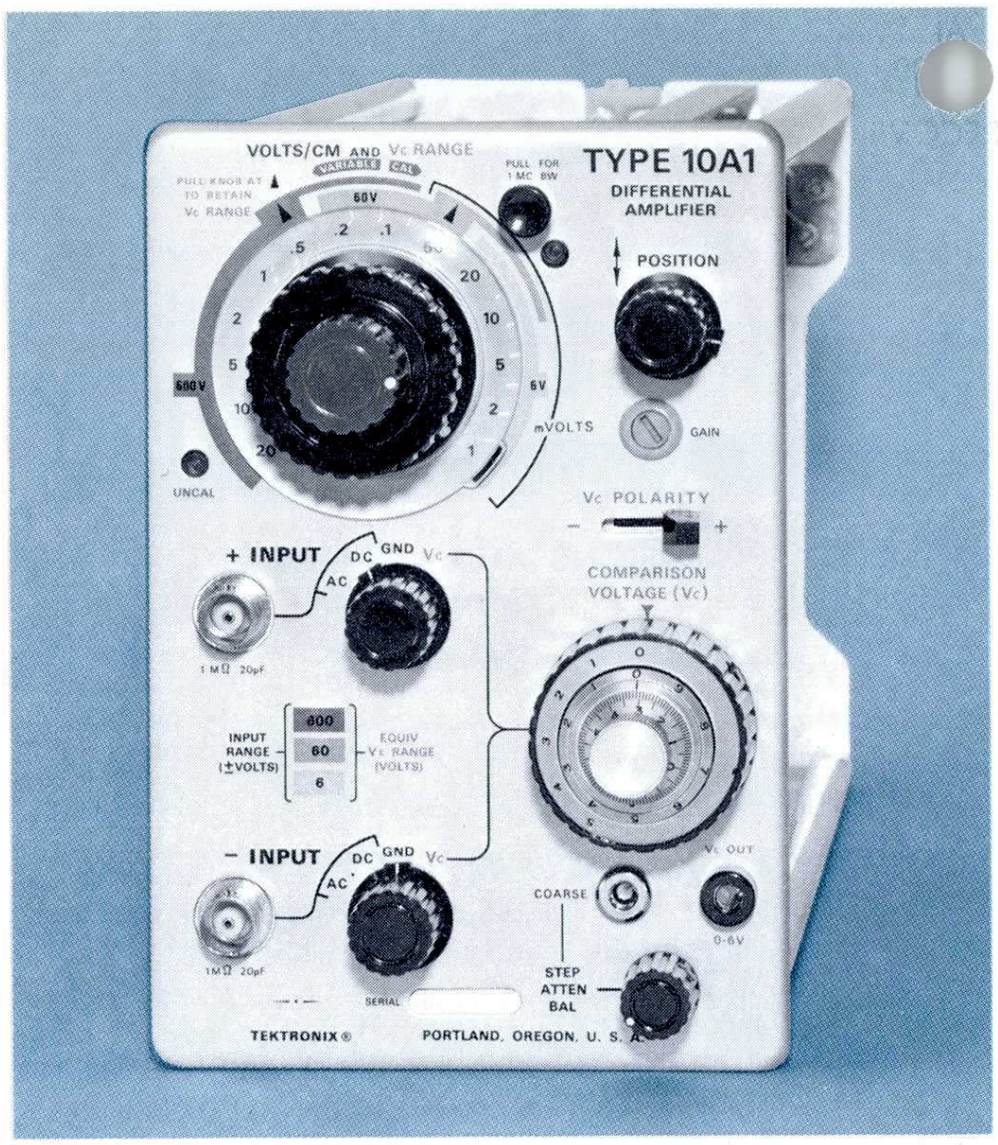
Order Type 201-2 . . . . . $155

*Registered Trademark, Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

55-MHz Differential Comparator

10A1



- ***1 mV/cm-to-20 V/cm CALIBRATED DEFLECTION FACTOR***
- ***1000:1 COMMON-MODE REJECTION FROM DC TO 10 MHz***
- ***EQUIVALENT OFFSET VOLTAGE UP TO ±600 V PROVIDES 4-DIGIT RESOLUTION FOR ACCURATE AMPLITUDE MEASUREMENTS***

The Type 10A1 combines the features of a conventional amplifier, a differential amplifier, and a calibrated differential comparator in a single plug-in unit for Type 647A and R647A Oscilloscopes. Rapid recovery from large differential overload allows detailed study of pulse-top flatness as well as comparator measurement of transient amplitudes. The effective 6,000-cm slide-back scale and 20,000:1 common-mode rejection ratio permit accurate measurements and comparisons. Rugged design insures accuracy over the same range of environmental conditions as stated for Type 647A and R647A Oscilloscopes.

CONVENTIONAL AMPLIFIER

BANDWIDTH AND RISETIME

Bandwidth is specified at 3-dB down. Bandwidth may be limited to 1 MHz ±10%, when desired, for noise reduction at higher sensitivities. AC coupling provides a low-frequency 3-dB point at ≈1.6 Hz. Use of the P6047 10X probe with AC coupling extends the low-frequency 3-dB point to 0.16 Hz.

BANDWIDTH AND RISETIME WITH OR WITHOUT P6047 10X PROBE		
DEFLECTION FACTOR	0° C to +40° C	−30° C to +65° C
5 mV/cm to 20 V/cm	55 MHz and 6.4 ns	50 MHz and 7 ns
1 mV/cm and 2 mV/cm	35 MHz and 10 ns	35 MHz and 10 ns

MAXIMUM INPUT VOLTAGE

Maximum combined DC and Peak AC is ±20 V when using 1-mV/cm to 20-mV/cm deflection factors, ±600 V when using the 50-mV/cm to 20-V/cm deflection factors.

DEFLECTION FACTOR

1 mV/cm to 20 V/cm in 14 calibrated steps (1-2-5 sequence). Continuously variable (uncalibrated) between steps and to approx 50 V/cm. Deflection factor can be calibrated at any step with front-panel GAIN adjustment. When GAIN has been accurately adjusted at 5 mV/cm, accuracies are as follows:

VOLTS/CM ACCURACY		
DEFLECTION FACTOR	0°C to +40°C	−30°C to +65°C
1 mV/cm (also 10 mV/cm and 0.1 V/cm with Vc range extended)	±2.5%	±4%
2 mV/cm through 2 V/cm (except 10 mV/cm and 0.1 V/cm with Vc range extended)	±1.5%	±2.5%
5 V/cm through 20 V/cm	±3%	±4%

INPUT RC

1 megohm paralleled by 20 pF.

DIFFERENTIAL AMPLIFIER

COMMON-MODE REJECTION RATIOS

Values stated apply at a deflection factor of 1 mV/cm and from 0° C to +40° C.

COMMON-MODE REJECTION DC COUPLED		
FREQUENCY RANGE	REJECTION RATIO	RANGE OF PEAK-TO-PEAK INPUT SINEWAVE
DC to 100 kHz	20,000:1	0 V to 10 V
100 kHz to 1 MHz	10,000:1	0 V to 10 V
1 MHz to 10 MHz	10,000:1* divided by freq in MHz	0 V to 10 V* divided by freq in MHz
20 MHz	100:1	0 V to 1 V
AC COUPLED		
60 Hz	2,000:1	0 V to 10 V

*Divide CMRR and voltage by the frequency in MHz; e.g., at 2 MHz the CMRR is 5,000:1 up to 5 V input amplitude.

At 10 mV/cm, using the internal 10X attenuator, CMRR is 00:1 for 20-V peak-to-peak 10 kHz sinewave.

RECOVERY TIME

≤0.5 μs for a return to within ±2 mV after differential offset. Recovery DC error ≤0.5 mV after 1-ms recovery time. Characteristics apply from 0° C to +40° C.

CALIBRATED DIFFERENTIAL COMPARATOR

Comparison Voltage (Vc) can be used to offset the input waveform via the slide-back technique. The internal Vc source allows measurement, with 4-digit resolution, of signal amplitudes up to ±600 V. Equivalent Vc range is normally selected simultaneously with deflection factor, but may be extended for two additional steps. Bandwidth and risetime in the extended Vc positions are the same as at 1 and 2 mV/cm.

INPUT VOLTAGE		
DEFLECTION FACTOR	LINEAR DYNAMIC RANGE and EQUIVALENT Vc RANGE	MAXIMUM COMBINED DC AND PEAK AC
1 mV/cm through 20 mV/cm	±6 V	±20 V
10 mV/cm through 0.2 V/cm	±60 V	±600 V
0.1 V/cm through 20 V/cm	±600 V	±600 V

Vc CHARACTERISTICS			
EQUIVALENT Vc RANGE	SLIDEBACK MEASUREMENT ACCURACY		DEFLECTION FACTOR
	0°C to +40°C	−30°C to +65°C	
6 volts	±(0.1% + 5 mV)	±(0.15% + 8 mV)	1 mV/cm through 20 mV/cm
60 volts	±(0.225% + 50 mV)	±(0.4% + 80 mV)	10 mV/cm through 0.2 V/cm*
600 volts	±(0.35% + 0.5 V)	±(0.65% + 0.8 V)	0.1 V through 20 V/cm*

*Pull knob to retain Vc range at two lowest deflection factors.

Vc OUTPUT

Available at front panel as well as internally. Output continuously variable from 0 to ±6 V (0 to ±0.6 V when deflection factor is set at 5, 10, or 20 V/cm). Accuracy is within ±(0.1% + 5 mV) from 0° C to +40° C and within ± (0.15% + 8 mV) from −30° C to +65° C. (Open circuit values).

Vc CHARACTERISTICS WITH P6023 PROBE			
EQUIVALENT Vc RANGE	SLIDEBACK MEASUREMENT ACCURACY		DEFLECTION FACTOR
	0°C to +40°C	−30°C to +65°C	
60 volts	±(0.225% + 50 mV)	±(0.4% + 80 mV)	10 mV/cm through 0.2 V/cm
600 volts	±(0.5% + 0.5V)	±(0.95% + 0.8 V)	0.1 V/cm through 0.2 V/cm*
6000 volts**	±(1% + 5 V)	±(2% + 8 V)	1 V/cm through 200 V/cm*

*Pull knob to retain Vc range at two lowest deflection factors.

**Probe rating is 1000 volts maximum.

WEIGHTS

Net weight	4¾ lb	2.2 kg
Domestic shipping weight	≈9 lb	≈4.1 kg
Export-packed weight	≈13 lb	≈5.9 kg

INCLUDED STANDARD ACCESSORIES

Two instruction manuals (070-0464-00).

TYPE 10A1 DIFFERENTIAL AMPLIFIER $1025

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience. See catalog accessory pages for additional information.

PROBES

P6023 10X Low-Capacitance Probe for use with Tektronix differential amplifiers is provided with ±2.5% adjustability of attenuation ratio; helpful in maintaining common-mode rejection ratio of the system. Order P6023 PROBE PACKAGE (010-0167-00 LOCKING BNC) $52

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

10A2A 100-MHz Dual-Trace Amplifier 10A2A

- ***3.5-ns RISETIME***
- ***10 mV/cm to 20 V/cm***
- ***DUAL TRACE, 5 OPERATING MODES***
- ***FRONT-PANEL CHANNEL-2 OUTPUT***
- ***TRIGGER SELECTION***

Bandwidth from DC to 100 MHz, with or without probe, makes the Type 10A2A an especially versatile plug-in unit for the Type 647A and Type R647A Oscilloscopes. Two identical channels can be added algebraically, operated singly with either polarity, or operated dual trace with alternate or chopped switching. The Type 10A2A is built to meet the same environmental requirements as Type 647A and R647A Oscilloscopes.

BANDWIDTH

Without probe or with P6047 10X Probe: DC to 100 MHz (3-dB down) from 0°C to +40°C or DC to 90 MHz (3-dB down) from —30° C to +65° C. Low-frequency 3-dB point with AC coupling is ≈1.6 Hz, ≈0.16 Hz with 10X probe.

RISETIME

Without probe or with P6047 10X Probe: 3.5 ns from 0° C to +40°C or 3.9 ns from —30°C to +65°C.

DEFLECTION FACTOR

Without Probe: 10 mV/cm through 20 V/cm in 11 calibrated steps (1-2-5 sequence). After calibration at 0.01 V/cm, and at the operating temperature, deflection-factor accuracy is within 2% for the other 10 steps. Deflection factor can be calibrated at any step with front-panel GAIN adjustment. Deflection factor continuously variable (uncalibrated) between steps and to approx 50 V/cm. With P6047 10X Probe: All deflection factors multiplied by 10. Probe attenuation accurate within 2% from —30°C to +65°C.

MAXIMUM INPUT VOLTAGE

600 V, DC + peak AC (≤1 kHz). Peak-to-peak AC not to exceed 600 V.

INPUT RC

1 megohm paralleled by 20 pF.

CHOPPED MODE

Switches channels at 1 MHz (±15%) rate, displaying approx 500-ns segments of each channel. Chopped-transient blanking is provided.

CHANNEL INVERSION

The display of either channel can be inverted for comparing signals 180° out of phase.

ADDED MODE

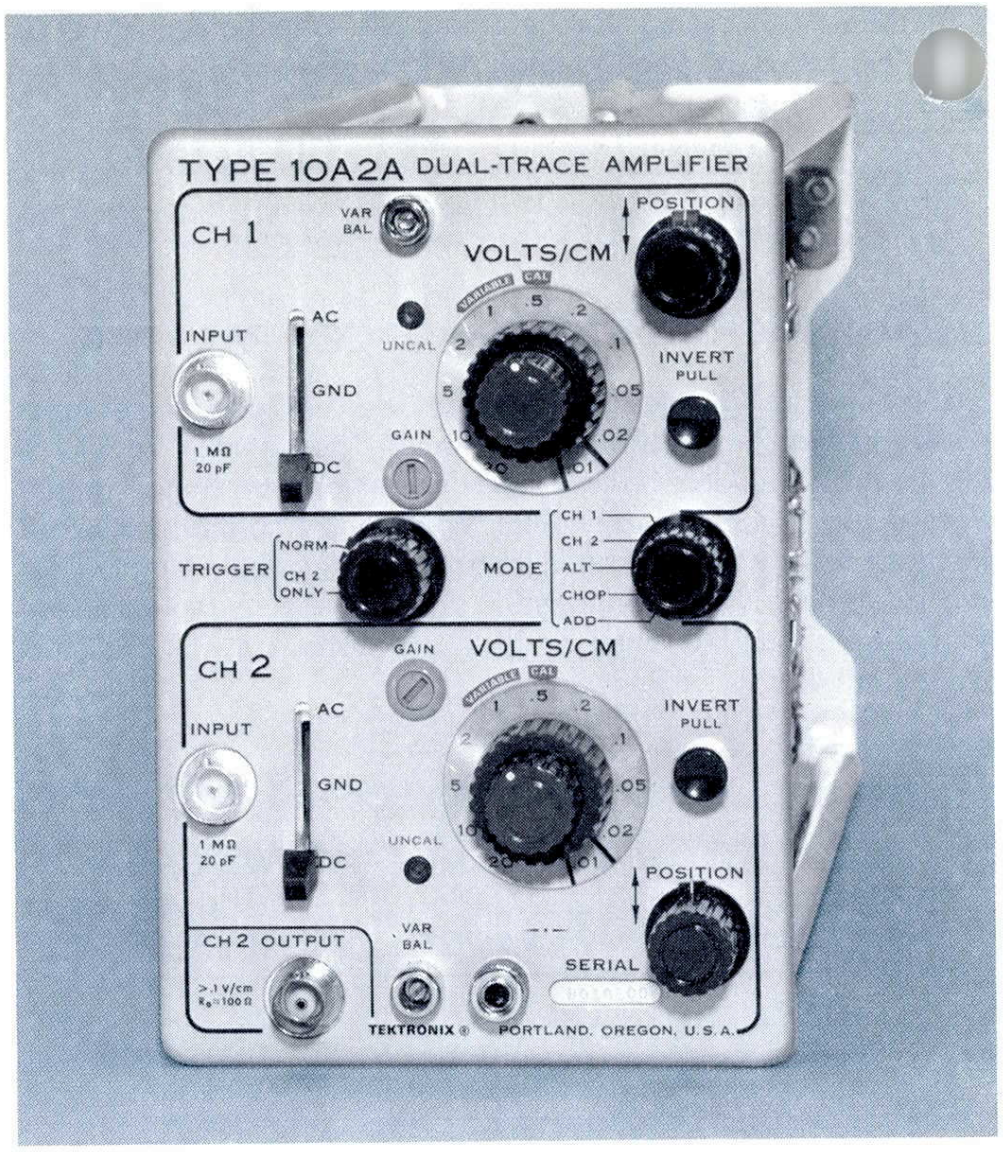
Common-mode rejection ratio 20:1 in added-algebraically mode for frequencies to 50 MHz and amplitudes to 10 cm.

CHANNEL ISOLATION (ATTENUATOR)

10,000:1 or greater for frequencies to 25 MHz.

CHANNEL-2 OUTPUT

Front-panel output with amplitude ≥100 mV per centimeter of Channel-2 display. Can be connected to Channel 1 in cascade for overall deflection factor of approx 1 mV/cm and bandwidth from DC to 40 MHz (3-dB down).



INTERNAL TRIGGER

Selectable triggering from common output amplifier or from Channel 2 only. Triggering from Channel 2 provides common time relationship between channels in Alternate or Chopped operation.

WEIGHTS

Net weight	5¼ lb	2.4 kg
Domestic shipping weight	≈9 lb	≈4.1 kg
Export-packed weight	≈13 lb	≈5.9 kg

INCLUDED STANDARD ACCESSORIES

Two instruction manuals (070-0615-00).

TYPE 10A2A DUAL-TRACE AMPLIFIER $885

OPTIONAL ACCESSORIES

The standard probe supplied with the Type 647A satisfies most measurement requirements. Optional probes, including high-voltage and current-measuring probes, may be better suited for particular applications. See catalog accessory pages for additional information on these and other items.

PROBES

P6011 1X Passive Probe Package, order 010-0193-00 . . $21

P6009 100X Passive Probe Package, order 010-0170-00 . . $66

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Time-Base

11B1

- ***10 ns/cm-to-2 s/cm SWEEP RANGE***
- ***DIRECT-READING MAGNIFIER***
- ***50-MHz TRIGGERING***
- ***SINGLE-SWEEP OPERATION***

The Type 11B1 is a Time-Base Plug-In Unit for Type 647A and R647A Oscilloscopes, and is built to meet the same environmental requirements. It features a single, wide-range sweep generator with a direct reading X1 to X50 magnifier. It provides normal sweeps to 0.1 μs/cm and direct-reading magnified sweeps to 10 ns/cm.

TIME BASE

0.1 μs/cm to 2 s/cm in 23 calibrated steps (1-2-5 sequence). Continuously variable (uncalibrated) between steps and to approx 5 s/cm. Free-run light warns the operator when sweep is not triggered.

DIRECT-READING MAGNIFIER

Up to X50 sweep expansion selected by TIME/CM switch.

ACCURACIES		
SWEEP RATES	0° C to +40° C	−30° C to +65° C
0.1 μs/cm to 50 ms/cm	±1.5%	±2.5%
0.1 s/cm to 2 s/cm	±3%	+4%, −6%
X10 MAG sweep accuracy		
10 ns/cm to 20 ns/cm	±3.5%	±5%
50 ns/cm to 5 ms/cm	±2.5%	±4%
10 ms/cm to 0.5 s/cm	±4%	+5.5%, −7.5%

EXTERNAL INPUT

0.1 V/cm to 2 V/cm in 5 steps, accurate within 2%; or, using ÷10 input attenuator, 1 V/cm to 20 V/cm in 5 steps, accurate within 5%. Continuously variable (uncalibrated) between steps. DC to 3 MHz (3-dB down). Low-frequency 3-dB point 16 Hz with AC coupling, 17 kHz with AC low-frequency reject. Input RC approx 1 megohm paralleled by approx 35 pF (EXT) or approx 10 megohm and 6 pF (EXT ÷ 10).

SIGNAL OUTPUTS

+ Gate (approx 15 V) and positive-going sawtooth (approx 10 V) outputs via front-panel BNC connectors.

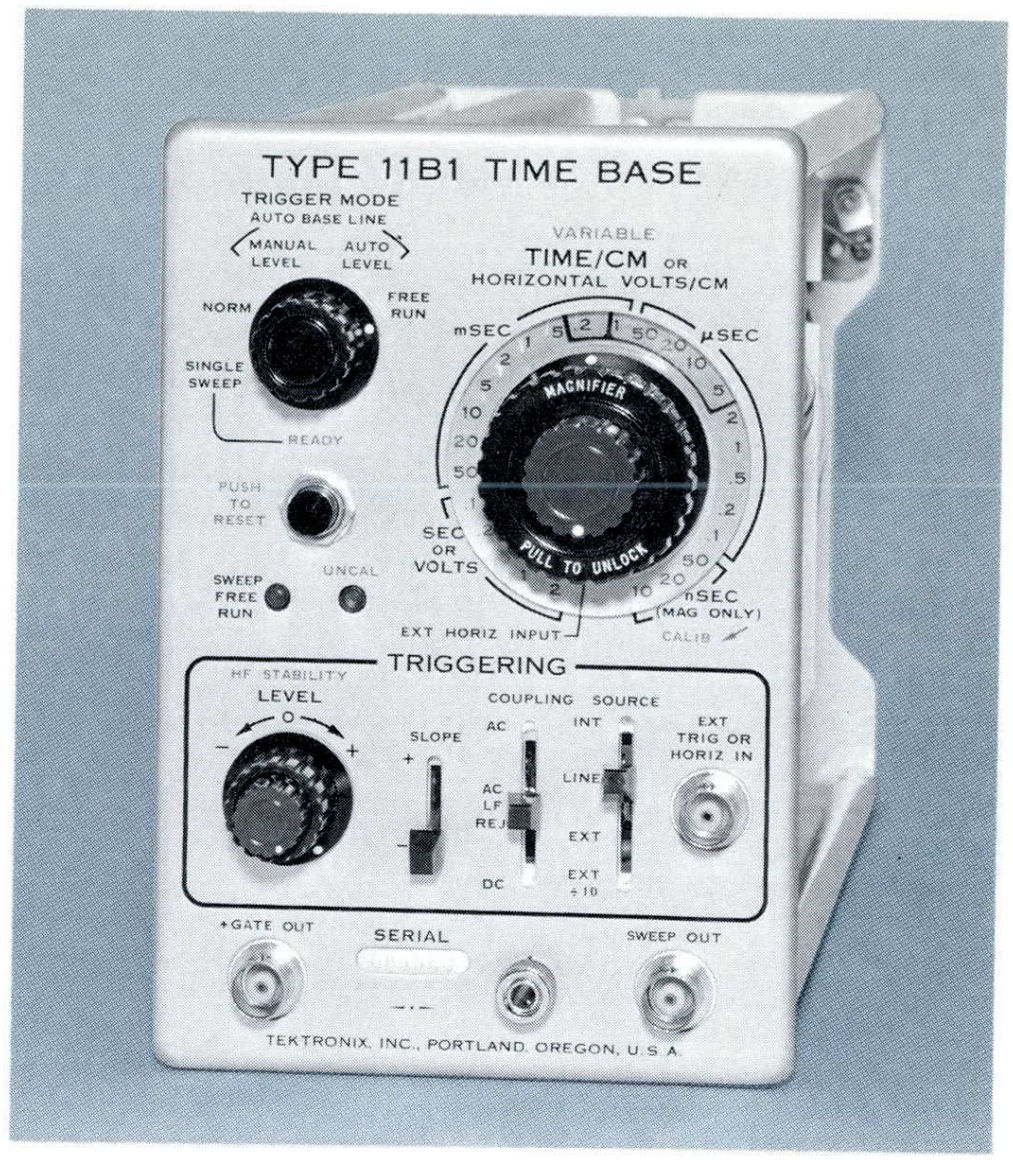
TRIGGER

MODES

Free-run, single-sweep, normal and 2 types of automatic baseline operation (manual or auto trigger level). Automatic baseline triggering is useful above 20 Hz and minimizes trigger adjustment for signals of different amplitudes, shapes and repetition rates. With no triggering signal, a recurring sweep provides a convenient reference trace.

AUTO-LEVEL AUTOMATIC OPERATION

Establishes triggering level near waveform average. Offers triggering convenience for most waveforms.



MANUAL-LEVEL AUTOMATIC OPERATION

Full operator control of triggering level for triggering on either + or − slope. Provides for effective triggering with small amplitude or low duty cycle signals.

COUPLING

DC, AC (3-dB down at approx 16 Hz) or AC LF Reject (3-dB down at approx 17 kHz).

SOURCES

Internal, external, external ÷ 10, or line. External trigger input RC approx 1 megohm paralleled by 35 pF (EXT) or 10 megohm and 6 pF (EXT ÷ 10).

REQUIREMENTS

2-mm deflection or 125 mV external from DC to 50 kHz, increasing to 1-cm deflection or 250 mV external at 50 MHz. Requirements applicable to normal triggering or automatic baseline, manual level.

HIGH-FREQUENCY STABILITY

Changes time-base recovery time to reduce high-frequency jitter.

OTHER

WEIGHTS

Net weight	4¾ lb	2.2 kg
Domestic shipping weight	≈ 8 lb	≈3.6 kg
Export-packed weight	≈13 lb	≈5.9 kg

INCLUDED STANDARD ACCESSORIES

Two instruction manuals (070-0424-01).

TYPE 11B1 TIME BASE $765

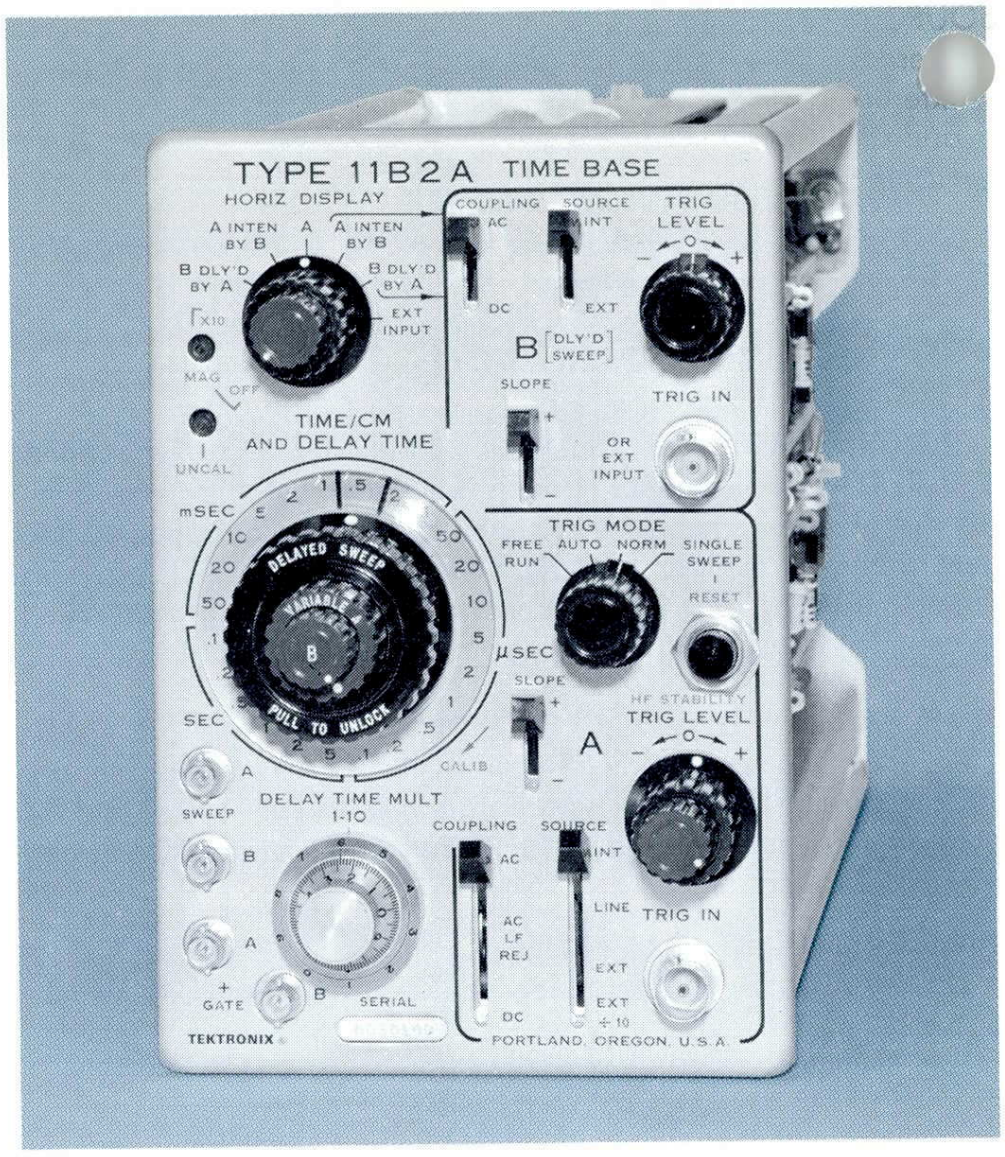
U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Sweep Delay Time Base

11B2A

- ***10 ns/cm-to-5 s/cm SWEEP RANGE***
- ***VERSATILE TRIGGERING TO 100 MHz***
- ***NORMAL AND DELAYED SWEEPS***
- ***SINGLE SWEEP FOR PHOTOGRAPHIC RECORDING***

The Type 11B2A is a Time-Base Plug-In Unit for Type 647A and R647A Oscilloscopes, and is built to meet the same environmental requirements. Two separate time-base generators and a calibrated sweep delay are provided. Time Base A is the normal sweep and is also used to delay the start of Time Base B.



TIME BASE A AND B

0.1 μs/cm to 5 s/cm in 24 calibrated steps (1-2-5 sequence). Continuously variable (uncalibrated) between steps and to approx 12.5 s/cm.

X10 SWEEP MAGNIFIER

Operates over the full range of both time bases. Increases the fastest rate to 10 ns/cm.

ACCURACIES		
SWEEP RATES	0° C to +40° C	−30° C to +65° C
0.1 μs/cm to 50 ms/cm	±1.5%	±2.5%
0.1 s/cm to 5 s/cm	±3%	+4%, −6%
X10 MAG sweep accuracy		
10 ns/cm to 20 ns/cm	±3.5%	±5%
50 ns/cm to 5 ms/cm	±2.5%	±4%
10 ms to 0.5 s/cm	±4%	+5.5%, −7.5%

DELAY RANGE

1 μs to 50 s, after delaying sweep start.

DELAY ACCURACIES		
	0°C to +40°C	−30°C to +65°C
DELAY TIME SETTING		
1 μs to 50 ms	Within 1%	Within 2%
0.1 s to 5 s	Within 2.5%	+3%, −6%
MULTIPLIER	Within 0.15% of full scale (1.5 minor dial divisions)	Within 0.2% of full scale (2 minor dial divisions)
DIFFERENTIAL TIME MEASUREMENTS		
1 μs to 50 ms	Within 1% and 3 minor dial divisions	Within 2% and 4 minor dial divisions
0.1 s to 5 s	Within 2.5% and 3 minor dial divisions	+3%, −6% and 4 minor dial divisions
JITTER	1 part or less in 20,000 of 10X DELAY TIME	

OPERATING MODES

A only, A intensified by B, B delayed by A. In the two latter modes, B can be started automatically at the end of A, or triggerable following the end of the delay period (providing a steady display of time-modulated pulses and signals with inherent jitter).

EXTERNAL INPUT

1 V/cm ±10% without magnification or 0.1 V/cm ±10% with X10 magnifier. Bandwidth is DC to 3 MHz (3-dB down). Low-frequency 3-dB point is 16 Hz with AC coupling. Input RC is 1 megohm paralleled by approx 30 pF.

SIGNAL OUTPUTS

Positive gates (approx 15 V) and positive-going sawtooths (approx 10 V) from both time bases.

TRIGGER

MODES

Normal, automatic, single-sweep, or free-run on Time Base A. Automatic operation is useful between approx 20 Hz and 100 MHz, minimizes trigger adjustments for signals of different amplitudes, shapes and repetition rates. With no input (or input less than 20 Hz), a recurring sweep provides a convenient reference trace.

COUPLING

AC, AC Low-frequency reject, or DC on Time Base A.

Sweep Delay Time Base

11B2A

SOURCES

Internal source selected from oscilloscope vertical amplifier, external, external ÷ 10, or line. External trigger input RC approx 1 megohm paralleled by approx 20 pF (EXT) or approx 10 megohm and approx 5 pF (EXT ÷ 10).

TIME-BASE A REQUIREMENTS

3-mm deflection or 125 mV external from DC to 20 MHz increasing to 2-cm deflection or 250 mV external at 100 MHz. Requirements increase below 60 Hz with AC coupling; below 50 kHz with AC low-frequency reject.

TIME-BASE B REQUIREMENTS

5-mm deflection or 200 mV external from DC to 20 MHz increasing to 3-cm deflection or 300 mV external at 100 MHz. Requirements increase below 60 Hz with AC coupling.

OTHER

WEIGHTS

Net weight	6½ lb	3.0 kg
Domestic shipping weight	≈10 lb	≈4.5 kg
Export-packed weight	≈14 lb	≈6.4 kg

INCLUDED STANDARD ACCESSORIES

BNC female to BSM female adapter (103-0036-00); two instruction manuals (070-0640-00).

TYPE 11B2A TIME BASE $970

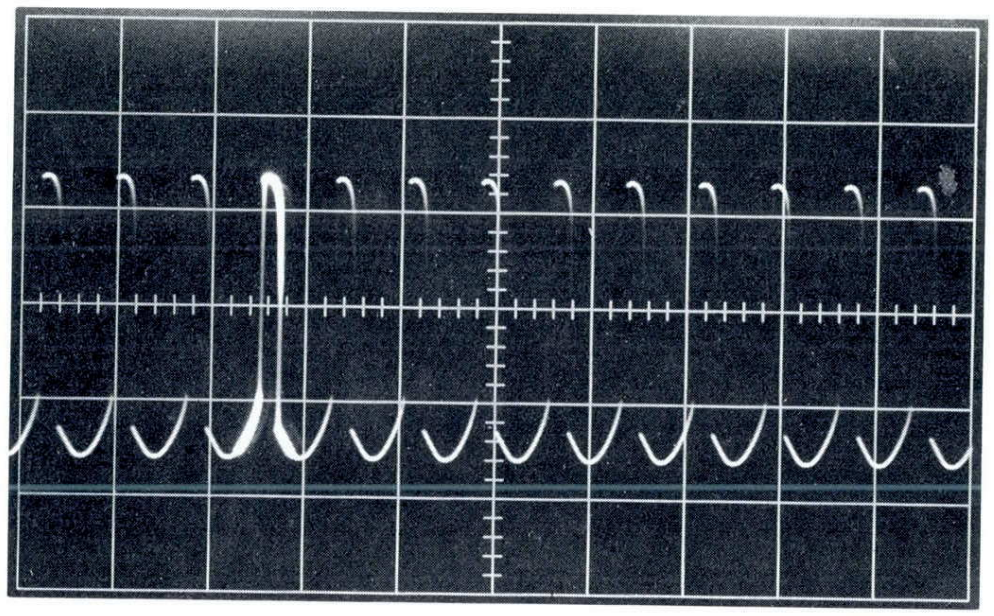
OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience. These and other accessory items are described in detail in the catalog accessory pages.

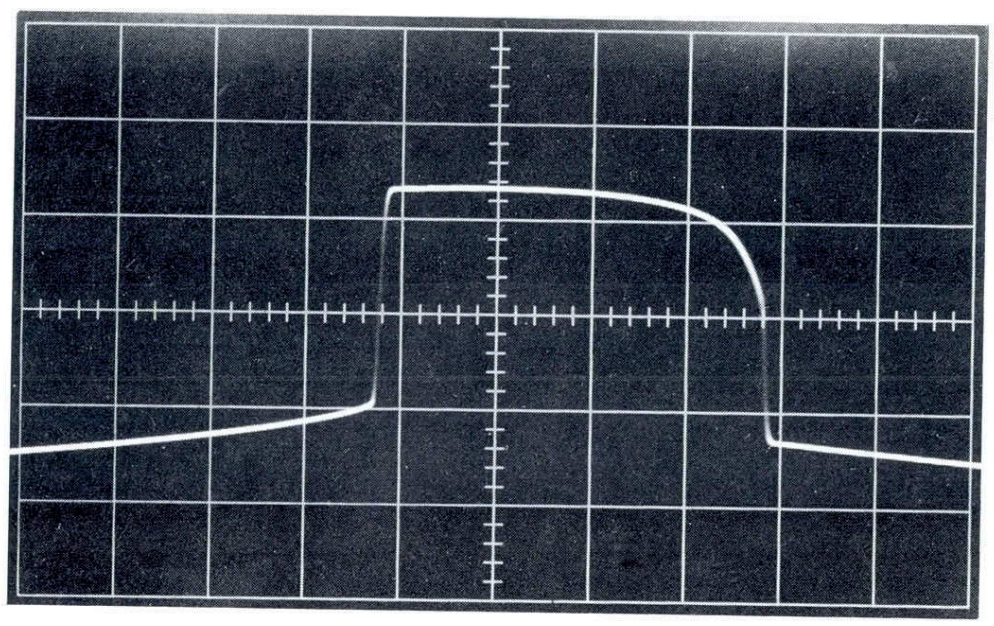
BNC-TO-BSM ADAPTER

Converts Type 11B2A front-panel outputs to accept BNC cables. Order 103-0036-00 ..... $5.50

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.



The waveform below (B delayed by A) is a X20 expansion of the intensified portion of the waveform above (A intensified by B). Time Base A at 2 μs/cm, Time Base B at 0.1 μs/cm.



Non-Plug-In Oscilloscopes Reference

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The non-plug-in oscilloscope incorporates a limited number of functions sufficient to do a given measurement job. Tektronix non-plug-in oscilloscopes offer a choice of bandwidth, deflection factor, single or multi-channel operation, single or differential operation and perform many more general applications well—at the expense of the additional versatility that a plug-in oscilloscope might provide.

Economies are realized at the expense of flexibility, since only a limited number of functions can be built into any given oscilloscope. Fixed applications, such as systems, are well suited to the non-plug-in oscilloscope. Basically low-frequency instruments, non-plug-in scopes offer high sensitivity and slow sweep rates, particularly suited for medical and mechanical applications. Two of the instruments, however, are medium frequency (DC to 15 MHz), semi-portable oscilloscopes that are useful for production-line testing, or general-purpose laboratory work.

Offered in the non-plug-in oscilloscope group is a dual-beam storage oscilloscope (5031), two conventional dual-beam oscilloscopes (5030, 502A), a single-beam, X-Y instrument (503), an inexpensive, 450-kHz oscilloscope (504), and two 15-MHz, general-purpose laboratory oscilloscopes, one having dual inputs (515A), the other (516) dual-trace capability.

Non-Plug-In Oscilloscopes Reference

Most of the oscilloscopes listed in the following section have *differential inputs* and as such, require explanation. An oscilloscope with a differential amplifier is a device that amplifies and displays a voltage difference that exists at every instant between signals applied to its two input channels. The following conclusions can be drawn from this definition when two signals are applied to the input of a differential amplifier.

1. If the two signals are in phase and of equal amplitude (called common-mode), the output will be zero (limited by the common-mode rejection ratio).

2. If the two signals are in phase but of different amplitude, the output will equal the amplitude difference.

3. If the two signals are out of phase and of equal amplitude, the output will be the vector difference between the two signals.

4. If the two signals are out of phase and of different amplitude, the output signal is a complex quantity derived from both amplitude and phase differences.

The following describes differential amplifier characteristics such as common-mode rejection, dynamic and frequency range, and basic measurement techniques.

COMMON-MODE REJECTION

The definition of the term "differential amplifier" implies a rejection of equal amplitude, coincident signals. This implication is correct. However, the degree of rejection depends primarily on the symmetry of the amplifier inputs. The amount of difference signal from a particular amplifier is documented with a mathematical relationship that is called the common-mode rejection-ratio (CMRR). This ratio and associated terms are defined as follows:

Common-Mode: Refers to signals that are identical with respect to both amplitude and time.

Common-Mode Rejection: The ability of a differential amplifier to reject common-mode signals.

Common-Mode-Rejection Ratio: The ratio of the amplitude of the common-mode input signal to the amplitude of the difference signal displayed on the CRT.

Since the differential amplifier is part of an oscilloscope, the output signal used to calculate the CMRR is measured from the CRT screen and volts per centimeter switch setting. Thus, a differential amplifier that produces a .005-volt output when driven by 5.0 volts of common-mode signal has a CMRR of 5/.005 or 1000:1.

FACTORS WHICH AFFECT CMRR

Frequency: Since the common-mode output voltage is a factor of phase difference, as well as gain between channels, the frequency of the input common-mode signal has a direct bearing on the CMRR. Generally as the frequency of the input signal increases the CMRR decreases. (Exception: With AC-coupled input the CMRR can become higher as frequency is increased within the 1 Hz to 100 Hz range.)

Source Impedance: The specified CMRR assumes the points being measured have identical source impedance. The source impedance and the amplifier input impedance form an RC divider which determines the portion of the signal that appears across the amplifier input, and the apparent effect on CMRR.

Signal Transporting Leads: A principal requirement for maximum CMRR is that the signals arrive at the two amplifier inputs in precisely the same phase and amplitude. Slight differences in attenuation factors, or phase shift between two input attenuators may reduce the CMRR 20% or more.

Ground Connections: Proper grounding reduces signals generated from ground-loop currents. It is best to electrically connect the probe or signal lead shields together at the probe body or instrument, but not to the signal source ground.

In differential measurements each input of the amplifier acts as a reference for the other and ground connections are only used for safety reasons. (The term differential input is synonymous with floating input.)

Non-Plug-In Oscilloscopes Reference

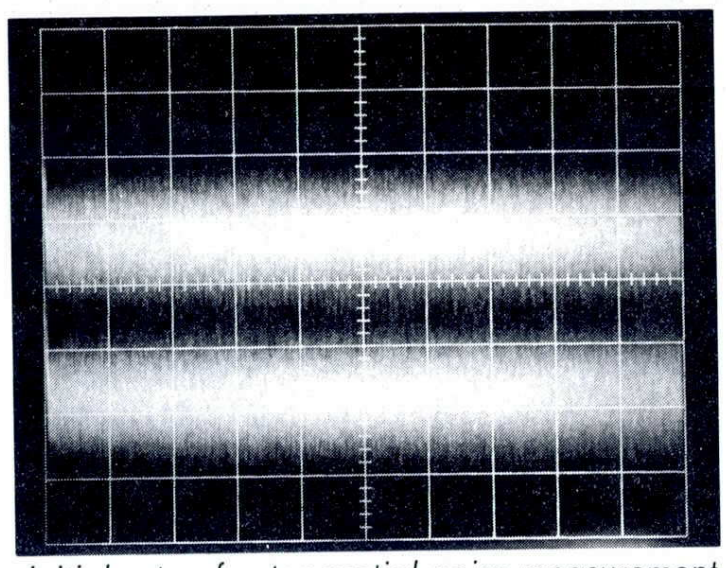
NOISE

Two instruments in this section (5030 and 5031) have displayed noise specifications. Noise is defined as random and specific unwanted variations of the trace on a cathode-ray tube—a limiting factor in high-sensitivity measurements with an oscilloscope. The amount of noise visible on a CRT display depends on the oscilloscope's bandwidth, deflection factor setting, the ambient temperature, power-line waveform characteristics, and other factors. Small amounts of noise usually have little effect on oscilloscope display interpretations. As a result, instruments with less than about 0.2-divisions of noise deflection do not generally have noise performance specified. Instruments with more than 0.2-divisions of noise deflection have performance areas which are limited and thus a performance specification is required.

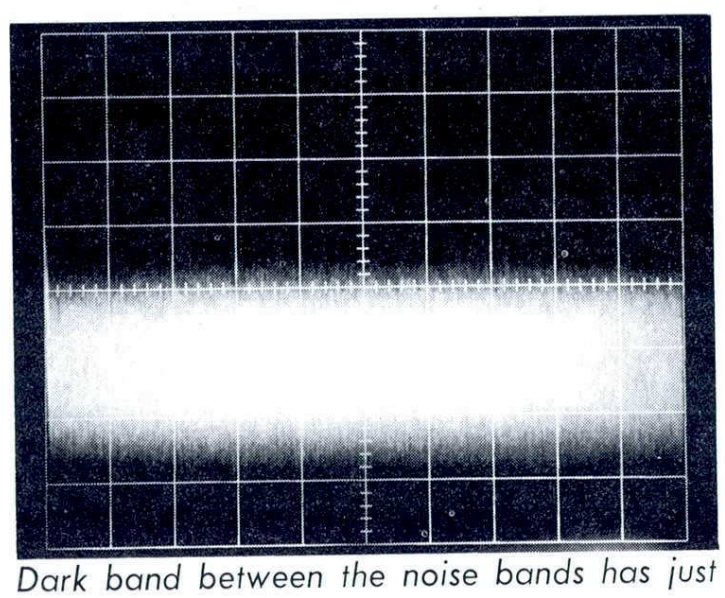
Three methods to measure and specify noise are presently used on conventional Tektronix instruments. 1. Determine the noise on the display by measuring it at some output point with a RMS voltmeter. 2. Observe the apparent trace width on the CRT. 3. Display a known signal and determine the amount of noise present by tangential measurement (display-noise).

Although the most repeatable means of measuring is with a RMS voltmeter, it is seldom used to describe noise for oscilloscope displays because osciloscope users are interested in a specification which can be measured directly from a CRT observation. The most convenient method of noise measurement is to determine the peak-to-peak vertical trace width noise. This requires no extra equipment but is useful only on small amounts of noise deflection where accuracies of ±50% or so are acceptable. Different amounts of noise are read at different times and the apparent noise value is changed by ambient lighting and trace intensity, thus this method is not adequate for verifying noise performance.

A measure of noise-limited resolution may be obtained by noting the vertical signal amplitude which will merge two noise traces into one. Noise measured in this manner is defined as displayed noise and is measured by the tangential noise measurement method. This method of stating the noise is more meaningful than the RMS value since it more closely approximates the actual effect of noise interfering with measurements. Tangential noise measurements are relatively simple and are useful with all noise-limited instruments. The equipment required is a squarewave generator, whose frequency is 1/10 the bandwidth of the oscilloscope, and a precision 100X attenuator. The displayed noise is measured by adjusting the oscilloscope trigger controls to a free-running sweep at about 0.2 ms/div. Set the oscilloscope vertical volts/div to the deflection factor where the noise is to be measured and apply the signal from the generator. Adjust the squarewave amplitude so two bands of noise can be observed on the CRT. Reduce the squarewave amplitude until the two noise bands merge (point where the darker bands between the noise bands just vanishes). Remove the 100X attenuator, change the oscilloscope deflection to a suitable value and measure the squarewave amplitude. Divide this amplitude by 100 to obtain the amplitude of displayed noise.



Initial setup for tangential noise measurement.



Dark band between the noise bands has just vanished.

For the common case of a qaussian noise amplitude distribution (eg: thermal resistance noise) tangentially measured displayed noise has a simple relationship to RMS noise. Displayed noise is about 2X RMS noise. The RMS meter is slightly more accurate than the displayed noise technique, but requires more care and additional equipment to make an accurate measurement. As a result, all new Tektronix low-frequency oscilloscopes specify displayed noise performance by the tangential method of measurement.

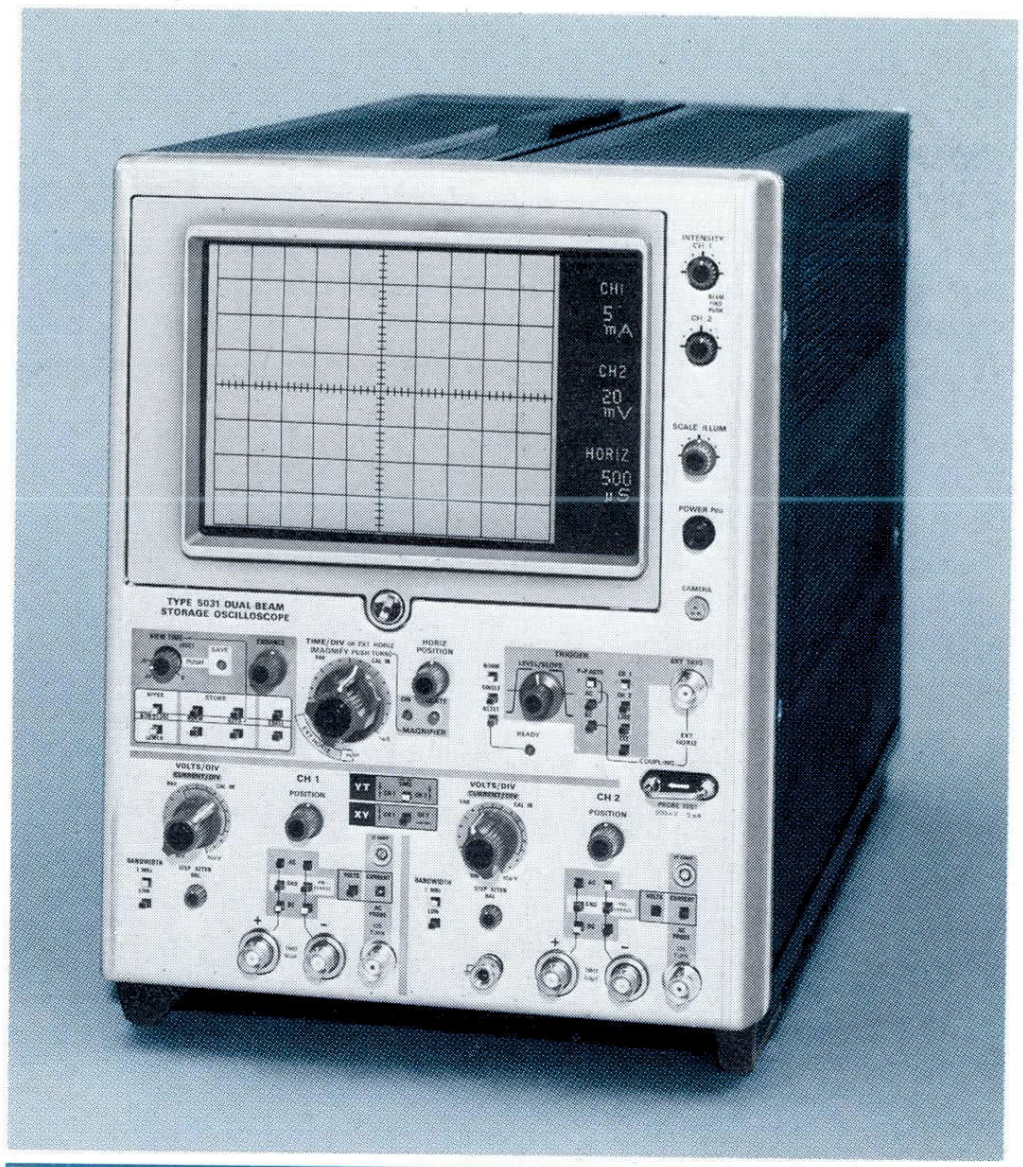
X-Y DISPLAYS

Four of the instruments listed in this section are capable of true X-Y operation. In this mode of operation, input signals may be applied to both the horizontal and vertical amplifiers and the display is a graph of the waveform on one channel versus the waveform on the other channel. The horizontal sweep is disabled. Examples of the use of the X-Y mode of operation are the plotting of hysteresis loops, of voltage across a semiconductor versus the current through it, and of force or pressure versus deformation or strain in a material. Use can be made of the differential input feature on one or both channels.

NEW

5031 Dual-Beam Storage Oscilloscope R5031

- SPLIT-SCREEN, BISTABLE STORAGE
- REMOTE ERASE
- 10 μV, DIFFERENTIAL, DC COUPLED
- SCALE-FACTOR READOUT
- CALIBRATED CURRENT INPUTS



The Type 5031 is the first dual-beam, split-screen, bistable, storage oscilloscope to offer calibrated current-probe inputs, high-gain differential-voltage inputs, auto scale-factor readout, and 1-MHz bandwidth.

Design of the Type 5031 stresses usability: simplified switching, color-coded functional controls, scale-factor readout, plus a large viewing area. Each beam has a full scan of 8 x 10 divisions (1.22 cm/div). The split-screen, bistable, storage CRT provides high-contrast displays and new convenience thru a variable viewing time system. Through front-panel controls this system can be directed to automatically erase either or both halves of the display area after a predetermined viewing time. Viewing time can be varied up to 5 s in the auto-store mode. Used in conjunction with single sweep, the auto-store mode automatically resets the single-sweep circuit at the end of the viewing time interval.

Two identical, solid-state input channels provide single-beam X-Y, or dual-beam Y-T displays either directly coupled or thru a current or voltage probe. Vertical channel bandwidth can be selected as 1 MHz or Low (5 kHz). Any unique bandwidth can be provided in the Low position by changing internal components.

A direct reading (via fiber-optics) magnifier of up to 50X is provided. A sweep-magnifier locate feature intensifies the sweep to show the time position of the magnified sweep. A new automatic-trigger mode provides a stable, triggered display regardless of other control settings for most repetitive waveforms, yet maintains trigger level and slope selection. Convenience features added to this instrument are beamfinders on the intensity controls and illuminated push buttons that indicate operating modes. Mode switching from a dual-beam Y vs T display to a X vs Y display is as simple as pressing a button.

The Type 5031 provides vertical sensitivity of 10 μV/div, calibrated current-probe inputs, as well as differential-voltage inputs and a constant bandwidth at all deflection factors. These measurement capabilities, plus the many convenience features, make this instrument useful in a wide variety of applications. The Type 5031 is available in three models: a conventional upright benchmount, a low-profile benchmount, or a 5-1/4 inch rackmount. Both the rackmount and cabinet models are designed for use in a laboratory environment.

CHARACTERISTIC SUMMARY

VERTICAL

Bandwidth—Selectable: DC to 1 MHz or DC to 5 kHz.
Deflection Factor—10 μV/div to 10 V/div or 1 mA/div to 200 mA/div.
Input RC—1 megohm paralleled by approximately 50 pF.
Common-Mode-Rejection Ratio—at least 100,000:1 (DC to 100 kHz).

HORIZONTAL

Time Base—1 μs/div to 5 s/div.
Magnifier—up to 5 magnification steps (X50 mag max).
External Input—20 mV/div to 0.5 V/div.

CRT

Display Area—each beam 8 x 10 div (1.22 cm/div).
Accelerating Voltage—4 kV.
Phosphor—P1.

OTHER

Amplitude Calibrator—0.5 V and 5 mA, 1-kHz square-wave.
Power Requirements—90 to 140 V or 180 to 275 V, 48 to 440 Hz; 100 watts.

DISPLAY MODES

Y-T (Two-Beam Display)—Normally, Channel 1 and Channel 2 plotted on vertical axes versus time on horizontal axis. Dual-beam curve tracing provided by plotting Channel 1 and Channel 2 on vertical axes against an external horizontal signal on horizontal axis. Y, Y, X phase difference is 5° from DC to 100 kHz, or AC coupled from 1 kHz to 100 kHz. The two vertical deflection systems are independent of each other and share the same horizontal deflection system.

X-Y (Single-Beam Display)—Channel 1 plotted on vertical axis versus Channel 2 on horizontal axis provides curve tracing at full sensitivity of vertical deflection system (10 μV/div). X-Y phase difference with Channel 1 and Channel 2 DC coupled at the same calibrated deflection factor (unused inputs grounded) is $\leq$1° to 200 kHz, increasing to $\leq$4° at 1 MHz. In X-Y mode, time and external horizontal systems are disabled and lamps are extinguished. Trace intensity is controlled by Channel 1 intensity control.

NEW

5031 Dual-Beam Storage Oscilloscope R5031

VERTICAL DEFLECTION

Two identical channels, each provided with differential voltage inputs and a separate current input. Voltage or current mode is selected by push button.

When current mode is enabled, lamps associated with voltage inputs are extinguished to avoid confusion. Volts switch extinguishes current lamp. Full 1-MHz bandwidth or Low (5-kHz) bandwidth for eliminating wide-band noise, selectable by push button.

Bandwidth

DC to 1 MHz within +20%, —10%, or DC to 5 kHz, within 10% at —3 dB, selectable by push button. Lower —3 dB limit: AC coupled 2 Hz or less; current mode 10 Hz or less.

Deflection Factor

Voltage Mode—10 μV/div to 10 V/div in 19 calibrated steps (1-2-5 sequence). Accurate within 3% from 50 μV/div to 10 V/div. Accurate within 4% when using split-screen storage. Accurate within 5% for 10 μV and 20 μV/div positions. Uncalibrated, continuously variable between steps to approximately 25 V/div.

Current Mode—1 mA/div to 200 mA/div in 8 calibrated steps (1-2-5 sequence) accurate within 5%. Uncalibrated, continuously variable between steps, extends deflection factor to approximately 500 mA/div.

Input RC

1 MΩ within 1% paralleled by 50 pF within 10%.

Displayed Noise

Voltage Mode: ≤15 μV.
Current Mode: ≤200 μA. (Tangentially Measured)

Input Gate Current

≤200 pA.

Maximum Safe Inputs

(Inputs are fuse protected—no damage will occur)

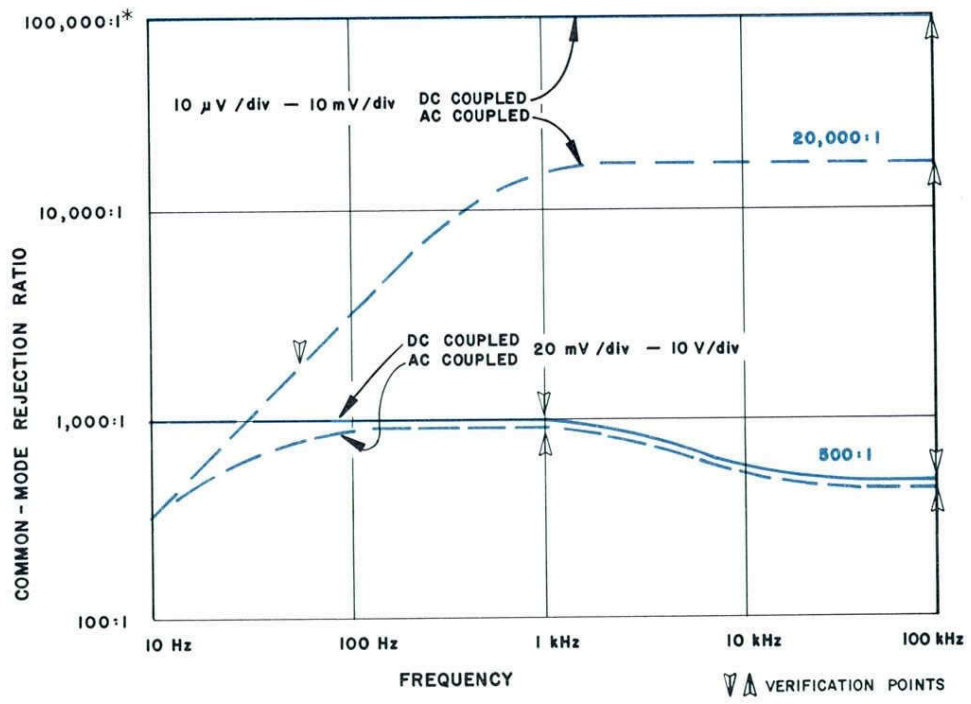
Voltage

Range	DC	AC*
10 μV to 100 mV/div	10 V (DC+Peak AC)	300 V DC, 10 V Peak AC
200 mV to 10 V/div	300 V (DC+Peak AC)	300 V (DC+Peak AC)

*Input switch must be initially set to ground when signal is applied to input to charge (or discharge) input coupling capacitor.

Current—10 A peak-to-peak.

Common-Mode-Rejection Ratio



*With up to 20-V peak-to-peak sinewave. CMRR is not specified when display is 0.1 div or less from DC to 1 kHz, or 0.2 div or less from 1 kHz to 100 kHz.

Trace Stability

With Time: Short term—5 μV or less per minute after one-hour warm up. Long term—10 μV or less or 0.1 division or whichever is greater, during any hour after 2.5-hour warm-up.
With Temperature: ≤50 μV per degree C.
With Line Voltage: ≤100 μV for 10% change in line voltage.

HORIZONTAL DEFLECTION

Full-range time base (1 μs to 5 s/div), up to 5 magnification steps (X50 maximum) and unique magnifier locate feature. Full-bandwidth (1-MHz) calibrated external-horizontal input permits dual-beam X-Y presentations. Horizontal deflection common to both beams.

Time Base Sweep Rate

1 μs to 5 s/div in 21 calibrated steps (1-2-5 sequence) accurate within 3% in the center 8 divisions. Accurate within 4% when using split-screen storage. Uncalibrated, continuously variable between steps and to approximately 12 s/div.

Sweep Magnifier

Up to 5 magnification steps (1-2-5 sequence) from the initial unmagnified time/div control setting. Maximum magnified sweep limited to 1 μs/div. Magnified time base accurate within 5% in the center 8 divisions of display. Locate push button disables magnifier and restores normal sweep display, intensifies that portion of sweep to be magnified. Horizontal position control acts as time position of that portion of sweep to be magnified.

Sweep Modes

Normal or single sweep; ready indicator lights when sweep circuit is triggerable.

External Horizontal Input

Bandwidth: DC to at least 900 kHz at —3 dB; lower —3 dB is 15 Hz or less.
Deflection Factor: 20 mV/div to 500 mV/div in 8 calibrated steps (1-2-5 sequence) accurate within 3% in the center 8 divisions. Accurate within 4% when using split-screen storage. Uncalibrated, continuously variable between steps to approximately 1.25 V/div.
Input RC: 1 MΩ within 2% paralleled by 50 pF within 10%.
Maximum Input: 100 V (DC + peak AC) decreasing to 100 V peak-to-peak at 1 MHz.
Y, Y, X Phase Difference: ≤5° from DC to 100 kHz; AC coupled from 1 kHz to 100 kHz.

TRIGGER

A simplified trigger circuit combines the trigger LEVEL and SLOPE controls and provides a peak-to-peak auto mode. When in peak-to-peak auto, the range of level adjustment is automatically established at the positive and negative peaks of the displayed waveforms. Also, the sweep is always triggered, or reverts to a free-running mode in the absence of a trigger signal or when the trigger signal is less than 15 Hz.

Coupling

Peak to Peak auto, AC or DC coupling. These push buttons select the coupling of trigger and external-horizontal input signals.

Source

Internal (Channel 1 or Channel 2), Line, or External.

NEW

5031 Dual-Beam Storage Oscilloscope R5031

Sensitivity

Coupling		Internal	External
Peak to Peak Auto	Norm	0.5 div, 15 Hz to 1 MHz	0.6 V, 15 Hz to 1 MHz
	Single	1.0 div, 15 Hz to 1 MHz	1.25 V, 15 Hz to 1 MHz
AC		0.3 div, 15 Hz to 1 MHz	0.4 V, 15 Hz to 1 MHz
DC		0.3 div, DC to 1 MHz	0.4 V, DC to 1 MHz

Maximum Input

100 V (DC + peak AC) decreasing to 100 V peak-to-peak at 1 MHz.

STORAGE CRT AND DISPLAY FEATURES

Auto Scale-Factor Readout

Reads out scale-factors associated with Channel 1, Channel 2 and Horizontal. CH 1 and CH 2 read 10 μV to 10 V in 19 steps or 1 mA to 200 mA in 8 steps (1-2-5 sequence). HORIZ reads 1 μs to 5 s in 21 steps or 20 mV to 500 mV in 8 steps (1-2-5 sequence). Scale illumination control selects intensity of readout.

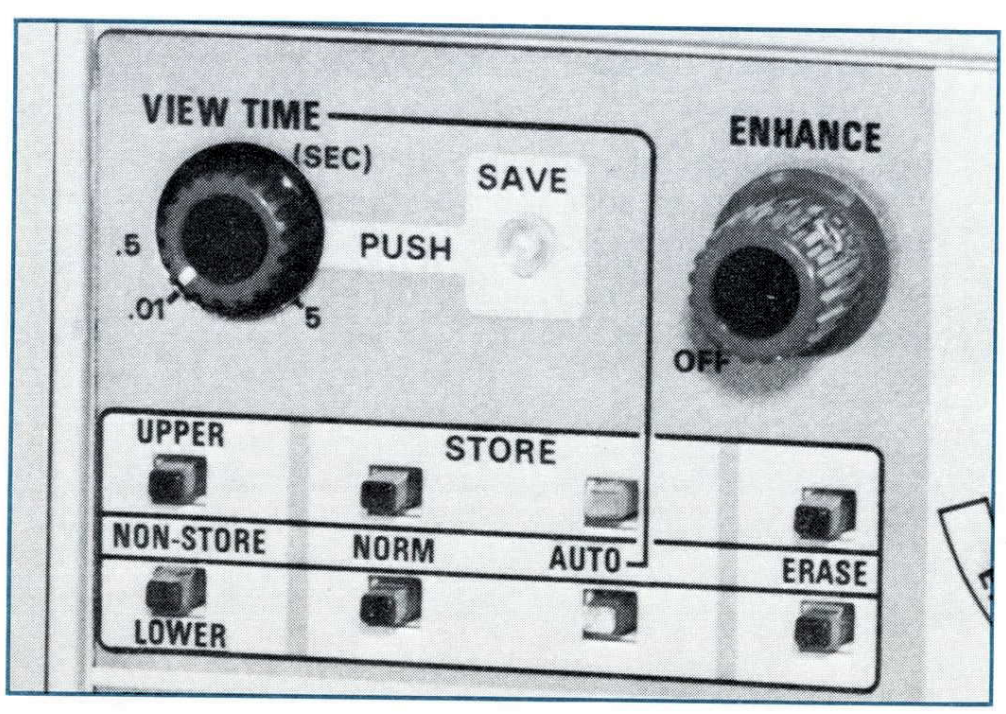
Dual-Beam Storage CRT

The CRT is a split-screen, bistable, storage device operated at 4-kV accelerating potential. Phosphor Type is P1 (no options). Each beam has a full scan of 8 x 10 divisions (1.22 cm/div). Separate vertical deflection plates; common horizontal. An internal 8 x 10 division graticule is provided. Vertical and horizontal center lines are marked in 0.2 divisions.

Split-Screen Storage

Store on either upper or lower half of screen with conventional display on other half. Store on entire screen or non-store on entire screen. Independent operation of both halves.

Writing Speed: At least 20 div/ms.
Contrast Ratio: At least 3:1.
Luminance: At least 10 foot-lamberts.
Viewing Time: Up to one hour.
Erase Time: 2 ms within 20%.
Enhance Mode: Controls single sweep writing capabilities of the storage CRT. Increases storage capabilities beyond 20 div/ms. with minimal loss of resolution and contrast.
Auto Store Mode: Viewing time continuously variable up to 5 s before the screen is erased and the sweep reset (Single Sweep Mode). A SAVE mode disables automatic erasure.



Display Controls

Combination push-button beam finder and intensity control for each beam. Dynamic focus eliminates requirement for control.

Remote Control Operation

The Type 5031 has remote-control operation capabilities using contact closure. A 9-pin connector, located on the rear panel, supplies one ground and 6 inputs (plus two spares) that allow the following functions:

1. Remote erase of upper screen and resetting of sweep for single-sweep operation.
2. Remote erase of lower screen and resetting of sweep for single-sweep operation.
3. Remote resetting of sweep for single-sweep operation.
4. Remote switching from storage operation to conventional operation of upper screen.
5. Remote switching from storage operation to conventional operation of lower screen.
6. Remote operation of the SAVE mode in order to hold a stored waveform.

Remote Control Unit
(Optional accessory, part number 012-0102-00)
Performs remote functions 1, 2, and 3.

OTHER CHARACTERISTICS

Rear Panel Inputs and Outputs

Z-Axis Inputs: Separate inputs for Channel 1 and Channel 2 DC to 1 MHz; 0 V to +12 V equal to full-intensity range, negative signal intensifies. Input RC approximately 20 kΩ paralleled by 60 pF. Maximum Input: 50 V (DC + peak AC).
Vertical Signal Outputs: Channel 1 and Channel 2 outputs provide an output of the vertical deflecting signal (DC coupled), amplitude at least 0.2 V per displayed div. Source impedance—10 kΩ within 10%. DC to $\geq$100 kHz bandwidth at —3 dB into 100 pF.
Auxiliary Functions: + Gate Output is $\geq$5 V from source impedance of 10 kΩ. Rise and fall times $\leq$5 μs into 100 pF.
Sawtooth Output: $\geq$5 V from source impedance of 10 kΩ.
Camera: Power to and sweep reset from camera to oscilloscope.

Probe Test

0.5 V into 1 MΩ and 5 mA accurate within 2%. Repetition Rate—1 kHz accurate within 15%.

Power Requirements

Quick-change, line-voltage selector permits operation from 90 V to 121 V, 105 V to 140 V, 180 V to 242 V, or 210 V to 275 V. The Type 5031 will operate over a line frequency range from 48 Hz to 440 Hz with a power consumption of 100 W at 115 V AC, 60 Hz.

Dimensions and Weights

Cabinet (Type 5031)		
Length	22-1/2 in	57.2 cm
Width	10 in	25.2 cm
Height	13 in	33.2 cm
Net weight	33 lb	15.0 kg
Domestic shipping weight	49 lb	22.2 kg
Export-packed weight	69 lb	31.4 kg

Upright Cabinet
Type 5031 is equipped with tilt bail. Includes two instruction manuals (070-1004-00).

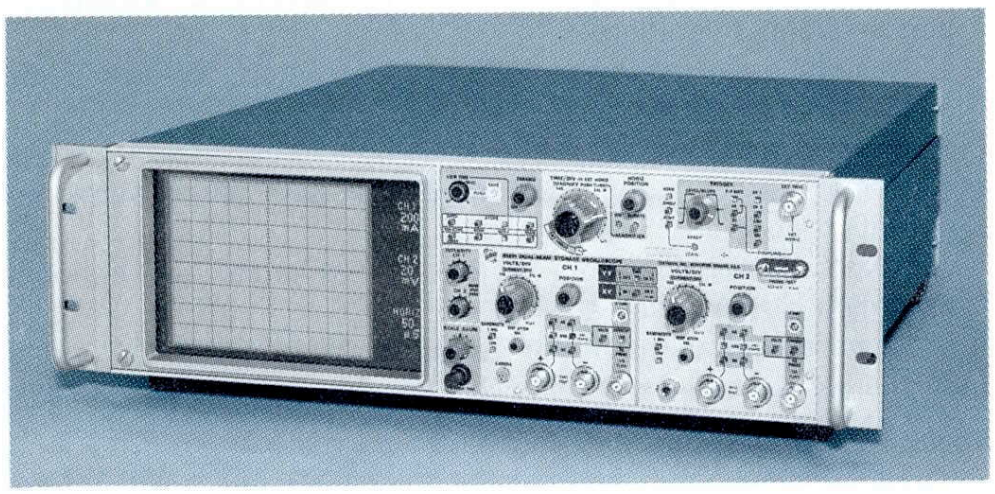
Order Type 5031 ..... **$2500**

NEW

5031 Dual-Beam Storage Oscilloscope R5031

Rackmount (Type R5031)

Length	22-1/2 in	57.2 cm
Width	19 in	48.3 cm
Height	5-1/4 in	13.4 cm
Net weight	33 lb	15.0 kg
Domestic shipping weight	49 lb	22.2 kg
Export-packed weight	69 lb	31.4 kg



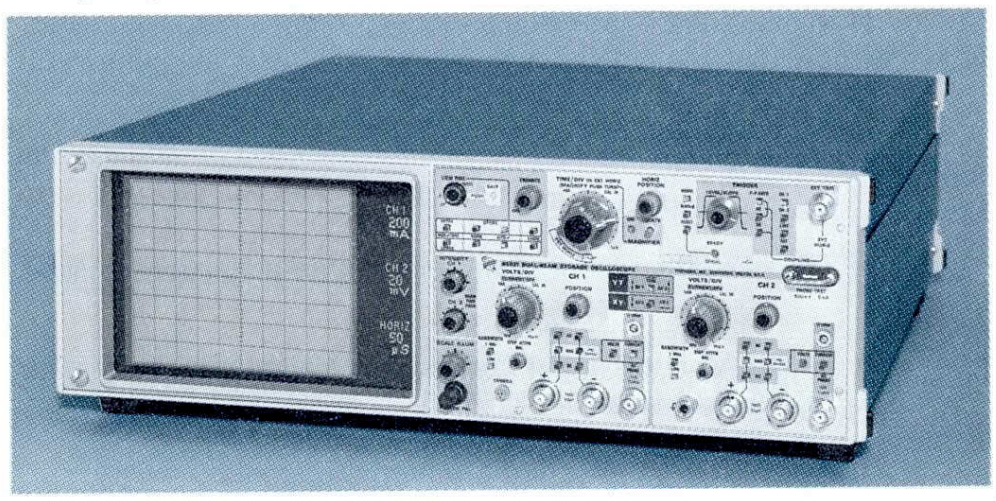
Rackmount

Type R5031 is equipped with a set of tracks and slides for rackmounting. Includes two instruction manuals (070-1005-00).

Order Type R5031 ..... $2500

Low-Profile Cabinet (Type R5031 Option 4)

Length	22-1/2 in	57.2 cm
Width	17-5/8 in	44.8 cm
Height	6 in	15.2 cm
Net weight	32 lb	14.6 kg
Domestic shipping weight	48 lb	21.8 kg
Export-packed weight	69 lb	31.4 kg



Low-Profile Cabinet

Type R5031 Option 4 is equipped with feet, tilt bail and handle for bench top use. Includes two instruction manuals (070-1005-00).

Order Type R5031 Option 4 ..... $2500

OPTIONAL ACCESSORIES

Optional accessories increase measurement capabilities and provide added convenience. Cameras, Probes, Scope-Mobile® Carts and other major accessories are completely described in the catalog accessory pages.

Probes

P6052 10X, 1X selectable attenuation probe, order 010-0241-00 ..... $ 55

P6021 AC current probe, order 010-0237-02 ..... $ 94

Scope-Mobile® Cart

Model 205-1, storage drawer, and 9-position tilt-lock oscilloscope tray, suitable for R5031, order 205-1 ..... $

Model 204-2 includes storage drawer and scope hold-down, suitable for 5031, order 204-2 ..... $155

Cameras

C-70 provides an f/1.9—1:0.575 lens for complete coverage of CRT and readout areas. Polaroid* Land Pack-Film back, order C-70-P (includes mounting bezel) $785

Standard C-12 provides no-parallax viewing, f/1.9—1:0.85 lens, Polaroid Land Pack-Film back, order C-12 .. $490

Standard C-27 has a rotating back and removable viewing hood, f/1.9—1:0.85 lens. Polaroid Land Pack-Film back, order C-27 ..... $460

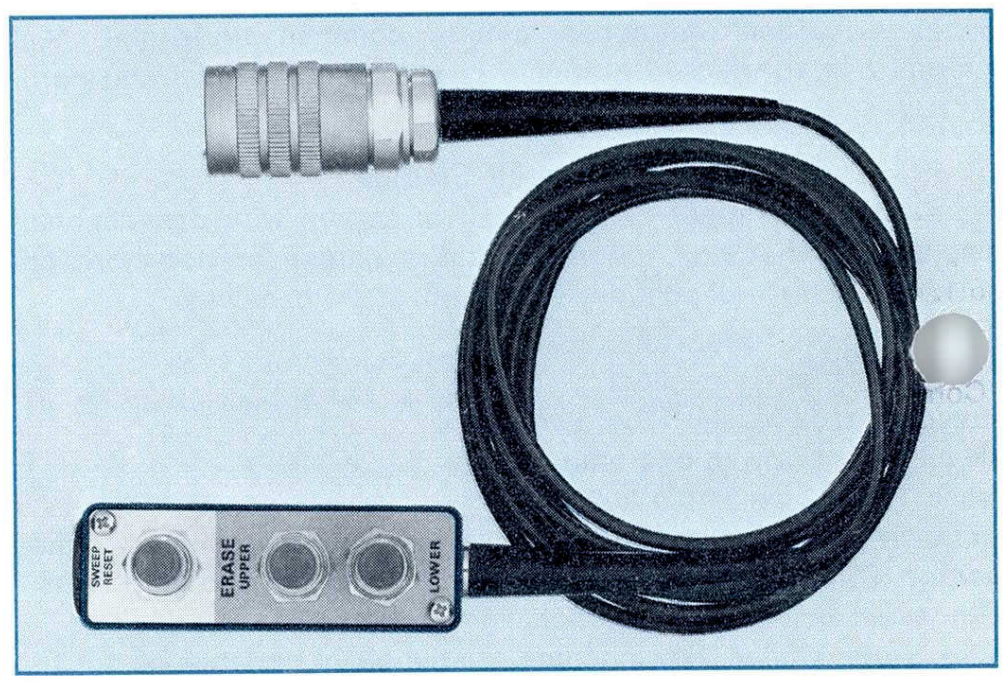
Camera Adapters

The C-70 mounts directly to the Type 5031. If a C-12 or C-27 is to be used, the adapter-frame/corrector lens and adapter is required.

Either the C-12 or C-27 camera can be used with the Type 5031 thru use of an adapter-frame/lens combination. The adapter frame accepts camera mounting adapter normally used for Tektronix 5-inch round CRTs. Order 016-0264-00, adapter-frame/corrector lens ..... $ 35

C-12 to 5-inch round CRT adapter, order 016-0226-01 .. $ 16

C-27 to 5-inch round CRT adapter, order 016-0225-02 .. $ 16



Remote-Control Unit

Separate controls for erase of upper screen, erase of lower screen, and single-sweep reset. Mates to oscilloscope rear-panel connector, 9-foot cable.

Order 012-0102-00 ..... $ 33

Remote-Control Connector

9-pin cable connector for selection of storage, non-storage, erase and reset functions.

Mates to oscilloscope rear-panel connector. Cable and control unit not included, order 134-0049-00 ..... $4.70

*Registered Trademark, Polaroid Corporation

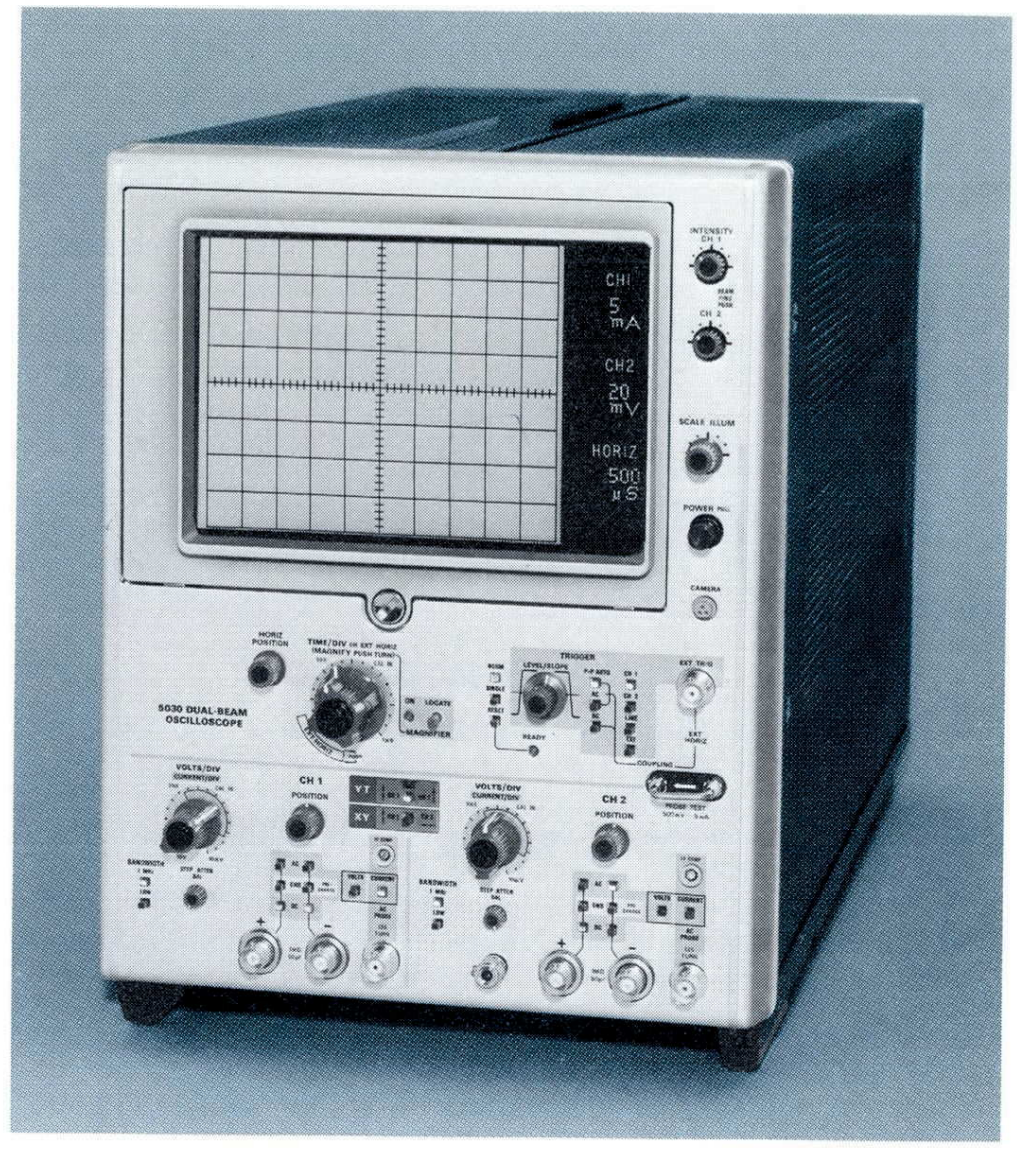
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

5030

Dual-Beam Oscilloscope

NEW

R5030



- 10 μV, DIFFERENTIAL, DC COUPLED
- SCALE-FACTOR READOUT
- CALIBRATED CURRENT INPUTS

The Type 5030 is the first dual-beam oscilloscope to offer calibrated current-probe inputs, high-gain differential inputs, auto scale-factor readout, and 1-MHz bandwidth. Three cabinet styles are available: a conventional, upright benchmount, a 5 1/4 inch rackmount, and a low-profile benchmount.

e adding more capability, the design stresses usability. Controls are color coded to outline functions, switching is simplified, scale-factors are read out via fiber-optics, and the viewing area of the CRT is increased by 50%. Each beam has a full scan of 8 x 10 divisions (1.27 cm/div). Readouts indicate current or voltage amplitude plus the time as set by the deflection controls.

A LOCATE function is associated with the time-base magnifier. When activated, the locate feature intensifies the sweep to show the time position of the magnified sweep.

The trigger circuit is greatly simplified by a peak to peak auto circuit. This automatic trigger mode provides a stable, triggered display regardless of other control settings for most repetitive waveforms, yet maintains triggering level and slope selection. In single-sweep mode the automatic trigger mode provides a triggered display without requiring triggering level adjustment.

Operator conveniences found on these instruments are beam finders and illuminated push-button switches. Additional capabilities which make the Type 5030 even more versatile: 1. The vertical sensitivity is 10 μV with a low-noise figure, as well as excellent differential common-mode-rejection ratio. 2. The vertical channels have current-probe inputs which allow simultaneous measurements of current and voltage. 3. The bandwidth is 1 MHz at all deflection factors (however, bandwidth may be limited to 5 kHz, allowing the operator to eliminate wide-band noise in his measurement). These measurement capabilities, plus the many convenience features, make these instruments useful in a wide variety of applications.

CHARACTERISTIC SUMMARY

VERTICAL

Bandwidth—Selectable: DC to 1 MHz or DC to 5 kHz.

Deflection Factor—10 μV/div to 10 V/div or 1 mA/div to 200 mA/div.

Input RC—1 megohm paralleled by approximately 50 pF.

Common-Mode-Rejection Ratio—at least 100,000:1 (DC to 100 kHz).

HORIZONTAL

Time Base—1 μs/div to 5 s/div.

Magnifier—up to 5 magnification steps (×50 mag max).

External Input—20 mV/div to .5 V/div.

CRT

Display Area—each beam 8 x 10 div (1.27 cm/div).

Accelerating Voltage—4 kV.

Phosphor—P31.

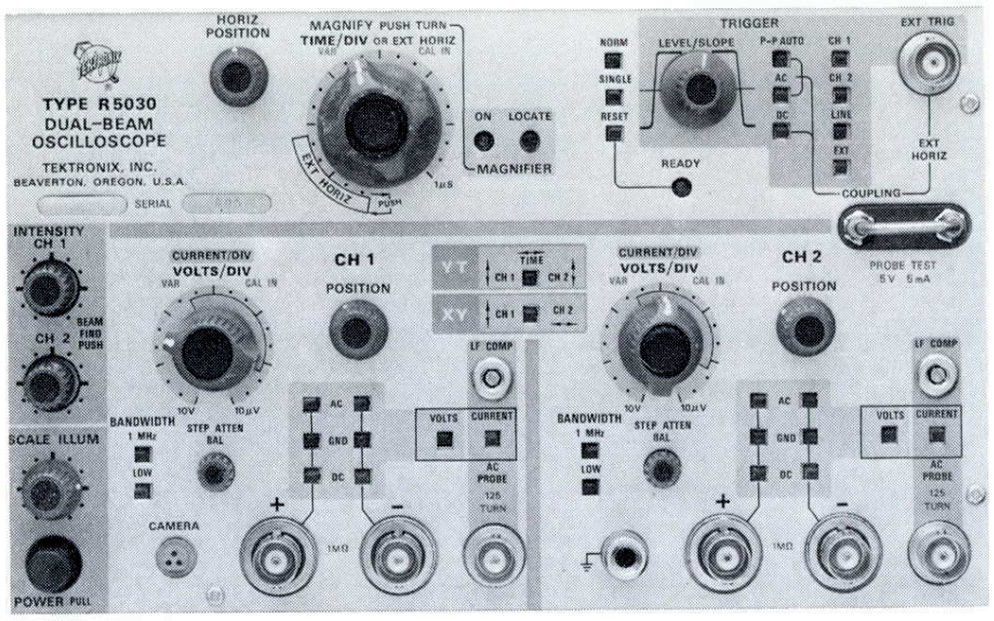
OTHER

Amplitude Calibrator—0.5 V and 5 mA, 1-kHz square wave.

Power Requirements—90 to 140 V or 180 to 275 V, 48 to 440 Hz; 100 watts.

NEW

5030 Dual-Beam Oscilloscope R5030



DISPLAY MODES

Y-T (Two-Beam Display)—Normally, Channel 1 and Channel 2 plotted on vertical axes versus time on horizontal axis. Dual-beam curve tracing provided by plotting Channel 1 and Channel 2 on vertical axes against an external horizontal signal on horizontal axis. Y, Y, X phase difference is 5° from DC to 100 kHz, or AC coupled from 1 kHz to 100 kHz. The two vertical deflection systems are independent of each other and share the same horizontal deflection system.

X-Y (Single-Beam Display)—Channel 1 plotted on vertical axis versus Channel 2 on horizontal axis provides curve tracing at full sensitivity of vertical deflection system (10 μV/div). X-Y phase difference with Channel 1 and Channel 2 DC coupled at the same calibrated deflection factor (unused inputs grounded) is $\leq$1° to 200 kHz, increasing to $\leq$4° at 1 MHz. In X-Y mode, time and external horizontal systems are disabled and lamps are extinguished. Trace intensity is controlled by Channel 1 intensity control.

VERTICAL DEFLECTION

Two identical channels, each provided with differential voltage inputs and a separate current input. Voltage or current mode is selected by push button.

When current mode is enabled, lamps associated with voltage inputs are extinguished to avoid confusion. Volts switch extinguishes current lamp. Full 1-MHz bandwidth or low (5-kHz) bandwidth for eliminating wideband noise, selectable by push button.

Bandwidth

DC to 1 MHz within +20%, —10%, or DC to 5 kHz, within 10% at —3 dB, selectable by push button. Lower —3 dB limit: AC coupled 2 Hz or less; current mode 10 Hz or less.

Deflection Factor

Voltage Mode—10 μV/div to 10 V/div in 19 calibrated steps (1-2-5 sequence). Accurate within 3% from 50 μV/div to 10 V/div. Accurate within 5% at 10 μV/div and 20 μV/div. Uncalibrated, continuously variable between steps to approximately 25 V/div.

Current Mode—1 mA/div to 200 mA/div in 8 calibrated steps (1-2-5 sequence) accurate within 5%. Uncalibrated, continuously variable between steps, extends deflection factor to approximately 500 mA/div.

Input RC

1 MΩ within 1% paralleled by 50 pF within 10%.

Displayed Noise

Voltage Mode: $\leq$15 μV.
Current Mode: $\leq$200 μA. (Tangentially Measured)

Input Gate Current

$\leq$200 pA.

Maximum Safe Inputs

(Inputs are fuse protected—no damage will occur)

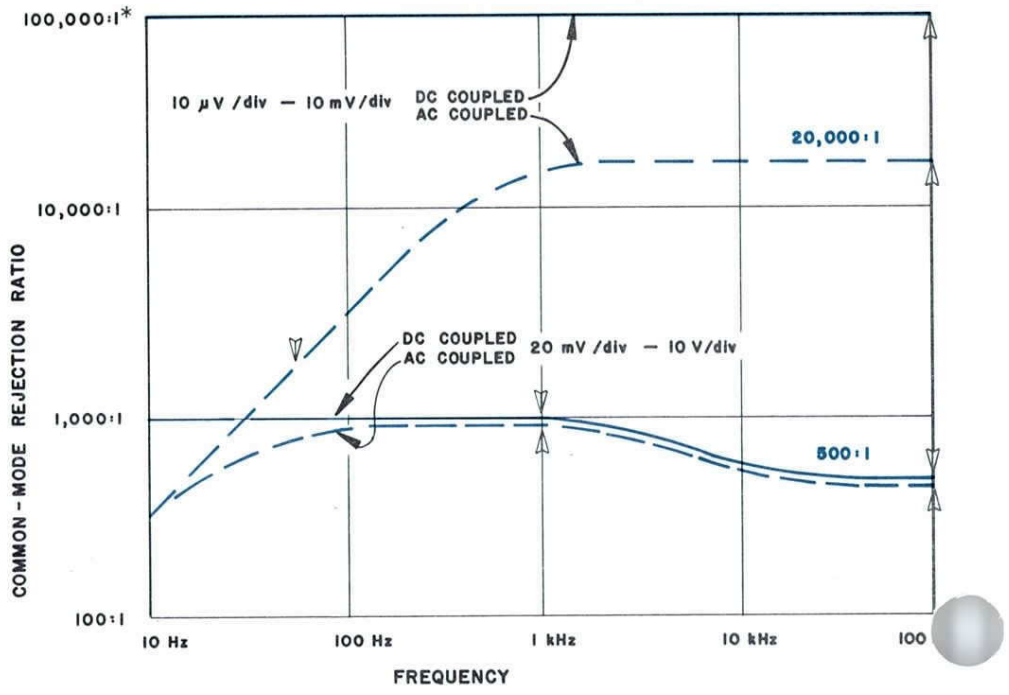
Voltage

RANGE	DC	AC*
10 μV to 100 mV/div	10 V (DC + Peak AC)	300 V DC, 10 V Peak AC
200 mV to 10 V/div	300 V (DC + Peak AC)	300 V (DC + Peak AC)

*Input switch must be initially set to ground when signal is applied to input to charge (or discharge) input coupling capacitor.

Current—10 A peak to peak.

Common-Mode-Rejection Ratio



*With up to 20-V peak-to-peak sinewave. CMRR is not specified when display is 0.1 div or less from DC to 1 kHz, or 0.2 div or less from 1 kHz to 100 kHz.

Stability

With Time: Short term—5 μV or less per minute after one-hour warm up. Long term—10 μV or less or 0.1 division or less, whichever is greater, during any hour after 2.5-hour warm up.

With Temperature: $\leq$50 μV per degree C.

With Line Voltage: $\leq$100 μV for 10% change in line voltage.

HORIZONTAL DEFLECTION

Full-range time base (1 μs to 5 s/div), up to 5 magnification steps (X5 maximum) and unique magnifier locate feature. Full-bandwidth (1-MHz) calibrated external-horizontal input permits dual-beam X-Y presentations. Horizontal deflection common to both beams.

Time Base Sweep Rate

1 μs to 5 s/div in 21 calibrated steps (1-2-5 sequence) accurate within 3% in the center 8 divisions. Uncalibrated, continuously variable between steps and to approximately 12 s/div.

Sweep Magnifier

Up to 5 magnification steps (1-2-5 sequence) from the initial unmagnified time/div control setting. Maximum magnified sweep limited to 1 μs/div. Magnified time base accurate within 5% in the center 8 divisions of display. Locate push button disables magnifier and restores normal sweep display, intensifies that portion of sweep to be magnified. Horizontal position control acts as time position of that portion of sweep to be magnified.

NEW

Sweep Modes

Normal or single sweep; ready indicator lights when sweep circuit is triggerable.

External Horizontal Input

Bandwidth: DC to at least 900 kHz at —3 dB; lower —3 dB limit is 15 Hz or less.

Deflection Factor: 20 mV/div to 500 mV/div in 8 calibrated steps (1-2-5 sequence) accurate within 3% in the center 8 divisions. Uncalibrated, continuously variable between steps to approximately 1.25 V/div.

Input RC: 1 MΩ within 2% paralleled by 50 pF within 10%.

Maximum Input: 100 V (DC + peak AC) decreasing to 100 V peak-to-peak at 1 MHz.

Y, Y, X Phase Difference: ≤5° from DC to 100 kHz; AC coupled from 1 kHz to 100 kHz.

TRIGGER

A simplified trigger circuit combines the trigger LEVEL and SLOPE controls and provides a peak-to-peak auto mode. When in peak-to-peak auto, the range of level adjustment is automatically established at the positive and negative peaks of the displayed waveforms. Also, the sweep is always triggered, or reverts to a free-running mode in the absence of a trigger signal or when the trigger signal is less than 15 Hz.

Coupling

Peak to Peak auto, AC or DC coupling. These push buttons select the coupling of trigger and external-horizontal input signals.

Source

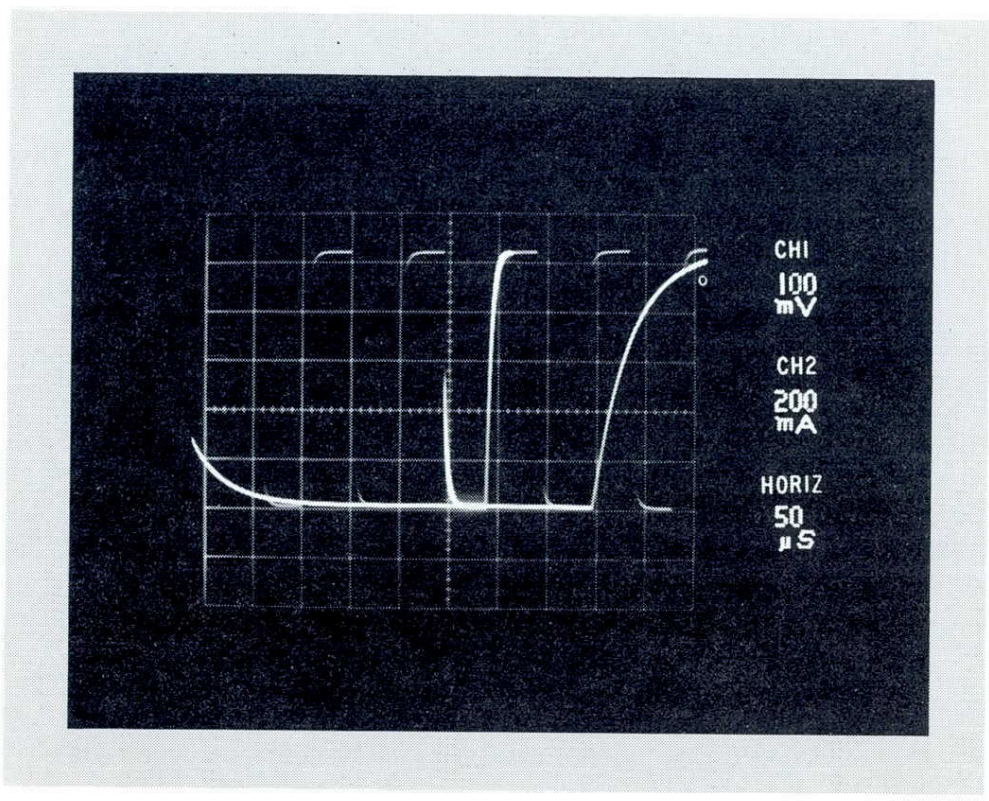
Internal (Channel 1 or Channel 2), Line, or External.

Sensitivity

Coupling		Internal	External
Peak to Peak Auto	Norm	0.5 div, 15 Hz to 1 MHz	0.6 V, 15 Hz to 1 MHz
	Single	1.0 div, 15 Hz to 1 MHz	1.25 V, 15 Hz to 1 MHz
AC		0.3 div, 15 Hz to 1 MHz	0.4 V, 15 Hz to 1 MHz
DC		0.3 div, DC to 1 MHz	0.4 V, DC to 1 MHz

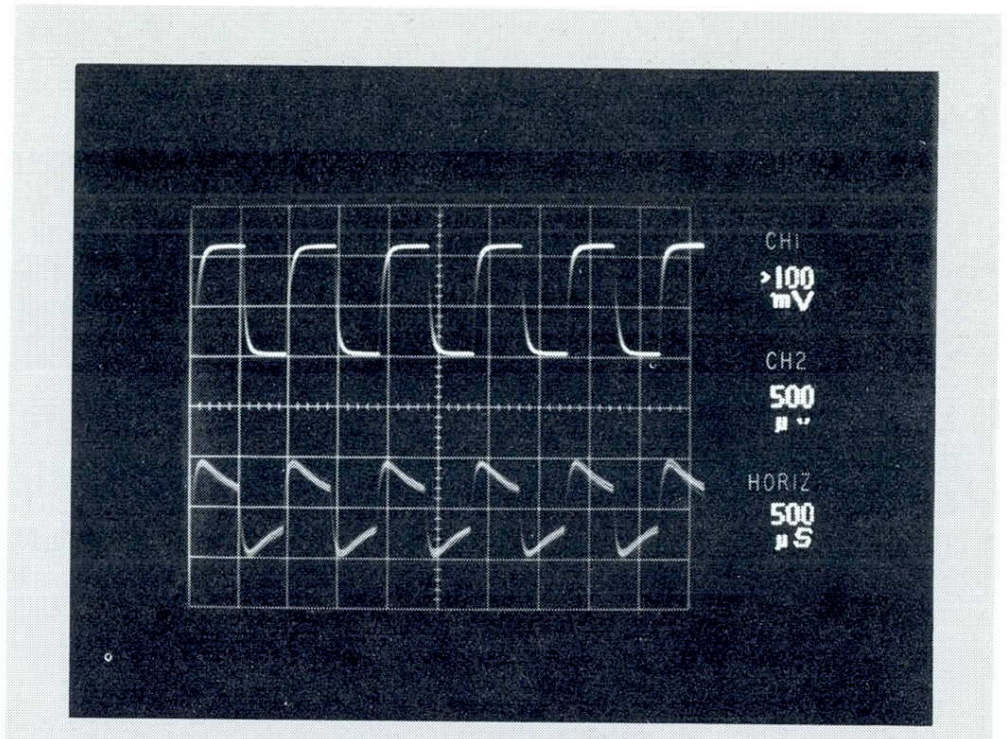
Maximum Input

100 V (DC + peak AC), decreasing to 100 V P-P at 1 MHz.



MAGNIFIER LOCATE (Double Exposure)

Magnifier Locate control depressed returns sweep to X1, intensifies portion of sweep to be magnified. When control is released, magnified sweep is displayed.



SCALE-FACTOR READOUT

Photo shows CH 1 variable volts control in uncalibrated condition, CH 2 mA/div out of range.

CRT AND DISPLAY FEATURES

Auto Scale-Factor Readout

Reads out scale-factors associated with Channel 1, Channel 2 and Horizontal. CH 1 and CH 2 read 10 µV to 10 V in 19 steps or 1 mA to 200 mA in 8 steps (1-2-5 sequence). HORIZ reads 1 µs to 5 s in 21 steps or 20 mV to 500 mV in 8 steps (1-2-5 sequence). Scale illumination control selects intensity of readout.

Tektronix Dual-Beam CRT

8 x 10 div per beam (1.27 cm/div). Separate vertical deflection plates; common horizontal. 4-kV accelerating potential provides a bright display. P31 phosphor normally supplied; P7 optional without extra charge. Consult your Field Engineer, Representative or Distributor for application information and availability.

Graticule

Internal, variable illumination. 8 x 10-div display area. Vertical and horizontal center lines marked in 0.2 divisions.

Display Controls

Combination push-button beam finder and intensity control for each beam. Dynamic focus eliminates requirement for control.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature

Operating: 0°C to +50°C (—15°C to +55°C with no functional failure)

Non-operating: —55°C to +75°C

Altitude

Operating: 15,000 feet

Non-operating: 50,000 feet

Vibration

Operating: 15 minutes along each axis at 0.015 inch peak-to-peak displacement (1.9 g's at 55 c/s). 10 to 50 to 10 c/s in 1-minute cycles.

Shock

Operating: 30 g's, 1/2 sine, 11-ms duration, 2 shocks in each direction along 3 major axes, total of 12 shocks.

NEW

5030 Dual-Beam Oscilloscope R5030

OTHER CHARACTERISTICS

Rear Panel Inputs and Outputs

Z-Axis Inputs: Separate inputs for Channel 1 and Channel 2 DC to 1 MHz; 0 V to +12 V equal to full-intensity range, negative signal intensifies. Input RC approximately 20 kΩ paralleled by 60 pF. Maximum Input: 50 V (DC + peak AC).

Vertical Signal Outputs: Channel 1 and Channel 2 outputs provide an output of the vertical deflecting signal (DC coupled), amplitude at least 0.2 V per displayed div. Source impedance—10 kΩ within 10%. DC to ≥100 kHz bandwidth at —3 dB into 100 pF.

Auxiliary Functions: + Gate Output is ≥5 V from source impedance of 10 kΩ. Rise and fall times ≤5 μs into 100 pF.

Sawtooth Output: ≥5 V from source impedance of 10 kΩ.

Camera: Power to and sweep reset from camera to oscilloscope.

Probe Test

0.5 V into 1 MΩ and 5 mA accurate within 2%. Repetition Rate—1 kHz accurate within 15%.

Power Requirements

Quick-change line-voltage selector permits operation from 90 V to 121 V, 105 V to 140 V, 180 V to 242 V, or 210 V to 275 V. The Type R5030 will operate over a line frequency range from 48 Hz to 440 Hz with a power consumption of 100 W at 115 V AC, 60 Hz.

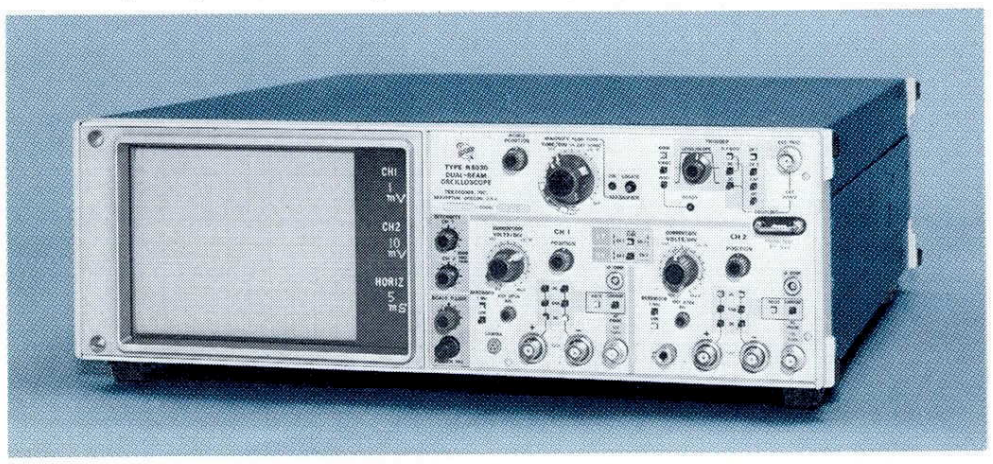
Dimensions and Weights

CABINET (Type 5030)

Length	22-1/2 in	57.2 cm
Width	10 in	25.2 cm
Height	13 in	33.2 cm
Net weight	33 lb	15.0 kg
Domestic shipping weight	49 lb	22.2 kg
Export-packed weight	69 lb	31.4 kg

Rackmount (Type R5030)

Length	22-1/2 in	57.2 cm
Width	19 in	48.3 cm
Height	5-1/4 in	13.4 cm
Net weight	33 lb	15.0 kg
Domestic shipping weight	49 lb	22.2 kg
Export-packed weight	69 lb	31.4 kg



Low Profile Cabinet (Type R5030 Option 4)

Length	22-1/2 in	57.2 cm
Width	17-5/8 in	44.8 cm
Height	6 in	15.2 cm
Net weight	32 lb	14.6 kg
Domestic shipping weight	48 lb	21.8 kg
Export-packed weight	69 lb	31.4 kg

UPRIGHT CABINET

Type 5030 is equipped with tilt bail. Includes two instruction manuals (070-0999-00).

Order Type 5030 ..... **$1850**

RACKMOUNT

Type R5030 is equipped with a set of tracks and slides for rackmounting. Includes two instruction manuals (070-1000-00).

Order Type R5030 ..... **$1850**

LOW-PROFILE CABINET

Type R5030 Option 4 is equipped with feet, tilt bail and handle for bench top use. Includes two instruction manuals (070-1000-00).

Order Type R5030 Option 4 ..... **$1850**

OPTIONAL ACCESSORIES

Optional accessories increase measurement capabilities and provide added convenience. Cameras, Probes, Scope-Mobile® Carts and other major accessories are completely described in the catalog accessory pages.

Probes

P6052 10X, 1X selectable attenuation probe, order 010-0241-00 ..... $55

P6021 AC current probe, order 010-0237-02 ..... $94

Scope-Mobile® Cart

Model 205-1, storage drawer, and 9-position tilt-lock oscilloscope tray, suitable for R5030, order 205-1 .... $150

Model 204-2 includes storage drawer and scope hold-down, suitable for 5030, order 204-2 ..... $155

Cameras

C-70 provides an f/1.9—1:0.575 lens for complete coverage of CRT and readout areas. Polaroid* Land Pack-Film back, order C-70-P (includes mounting bezel) $78

Standard C-12 provides no-parallax viewing, f/1.9—1:0.85 lens, Polaroid Land Pack-Film back, order C-12 ..... $490

Standard C-27 has a rotating back and removable viewing hood, f/1.9—1:0.85 lens. Polaroid Land Pack-Film back, order C-27 ..... $460

Camera Adapters

The C-70 mounts directly to the Type 5030. If a C-12 or C-27 is to be used, the adapter-frame/corrector lens and an adapter is required.

Either the C-12 or C-27 camera can be used with the Type 5030 thru use of an adapter-frame/lens combination. The adapter frame accepts camera mounting adapter normally used for Tektronix 5-inch round CRTs.

order 016-0264-00, adapter-frame/corrector lens $35

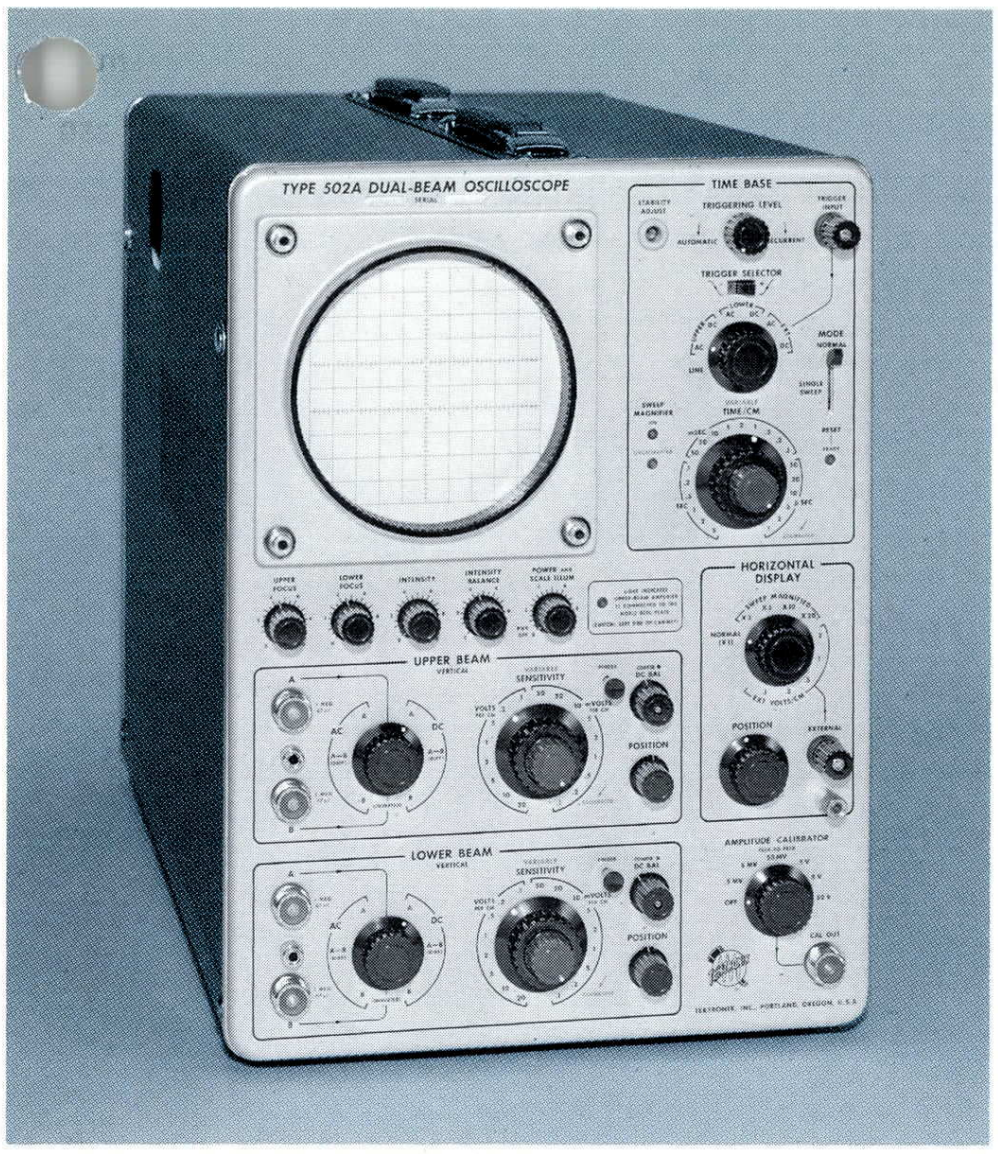
C-12 to 5-inch round CRT adapter, order 016-0226-01 ..... $16

C-27 to 5-inch round CRT adapter, order 016-0225-02 ..... $16

*Registered Trademark, Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

502A Dual-Beam Oscilloscope RM502A



- *100 μV DIFFERENTIAL INPUTS*
- *X-Y CURVE TRACING WITH 1 OR 2 BEAMS*

A wide range of measurement capabilities make the Type 502A and RM502A useful in a variety of applications including education, biology, defense, and production control. Differential or single-ended inputs can be used for dual-beam or single-beam X-Y displays as well as dual-beam or single-beam time-based displays. With one of the vertical amplifiers switched to provide horizontal deflection, full sensitivity is available for both axes. Phase shift is less than 1 degree from DC to 100 kHz. With the external horizontal amplifier switched to provide horizontal deflection, dual-beam X-Y plots can be displayed at full vertical sensitivity, and at 0.1 V/cm to 2 V/cm horizontally.

CHARACTERISTIC SUMMARY

VERTICAL

BANDWIDTH—DC to 100 kHz at 100 μV/cm, increasing to DC to 1 MHz from 5 mV/cm to 20 V/cm.

CALIBRATED DEFLECTION FACTOR—100 μV/cm to 20 V/cm.

INPUT RC—1 megohm paralleled by approx 47 pF.

COMMON-MODE REJECTION—At least 50,000:1 (DC to 50 kHz).

HORIZONTAL

CALIBRATED TIME BASE—1 μs/cm to 5 s/cm.

SWEEP MAGNIFIER—X2, X5, X10, X20.

EXTERNAL INPUT—0.1, 0.2, 0.5, 1 and 2 V/cm.

CRT

DISPLAY AREA—8 x 10 cm (each beam).

ACCELERATING VOLTAGE—2.9 kV.

PHOSPHOR—P2.

OTHER

AMPLITUDE CALIBRATOR—0.5 mV to 50 V, 1-kHz square-wave.

POWER REQUIREMENTS—105 to 125 V or 210 to 250 V, 50 to 60 Hz; 290 watts.

502A Dual-Beam Oscilloscope RM502A

APPLICATIONS

Here are just a few of the many possible uses for this versatile oscilloscope:

1. *Compare and measure the waveforms at two points in a circuit simultaneously.*
2. *Display X-Y curves with one or both beams in a variety of applications.*
3. *Plot one transducer output against another—pressure against volume or temperature, for instance.*
4. *Use the differential-input feature for cancellation of common-mode signals, and to eliminate the need for a common terminal, in both single and dual displays.*
5. *Measure phase angles and frequency differences.*

VERTICAL DEFLECTION

Two identical systems

BANDWIDTH

DC to ≥100 kHz (3-db down) at 100 μV/cm, increasing to DC to ≥1 MHz (3-db down) from 5 mV/cm to 20 V/cm. Low-frequency 3-dB-down point is ≤2 Hz with AC coupling, ≤0.2 Hz with included 10X probe.

DEFLECTION FACTOR

100 μV/cm to 20 V/cm in 17 calibrated steps (1-2-5 sequence), accurate within 2% (3% at 100 μV/cm). Uncalibrated, continuously variable between steps and to approx 50 V/cm.

INPUT RC

1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE (DC to 1 MHz)

50 V (combined DC + peak AC) from 100 μV/cm to 0.2 V/cm. 350 V (combined DC + peak AC) from 0.5 V/cm to 20 V/cm.

COMMON-MODE DYNAMIC RANGE

100 μV/cm to 0.2 V/cm — ±15 V.
0.5 V/cm to 20 V/cm — ±350 V.

COMMON-MODE REJECTION

DC Coupled

100 μV to 2 mV/cm: ≥50,000:1 from DC to 50 kHz; ±5-V signal.

5 mV to 200 mV/cm: ≤½-mm deflection from DC to 50 kHz; ±5-V signal.

500 mV to 20 V/cm: Adjustable to ≥500:1 from 1 kHz to 50 kHz; adjustable to ≥5,000:1 from DC to 1 kHz; ±50-V signal.

AC Coupled

2,000:1 (60 Hz).

DC DRIFT

Typically ≤400 μV/hour averaged over 10 hours, temperature and line voltage constant. ≤300 μV with line variation from 105 to 125 V AC.

DIRECT-COUPLED SIGNAL OUTPUTS

CF outputs for each amplifier at rear panel. Approx 2 V/each centimeter of displayed signal.

HORIZONTAL DEFLECTION

Common to both beams

TIME BASE

1 μs/cm to 5 s/cm in 21 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 12.5 s/cm. Warning light indicates uncalibrated setting.

SWEEP MAGNIFIER

X2, X5, X10, or X20 magnification; magnified time base accurate within 5%.

DISPLAY MODES

Normal or single sweep.

EXTERNAL INPUT

0.1 V/cm to 2 V/cm in 5 calibrated steps (1-2-5 sequence), accuracy within ±5%, DC to 100 kHz. 20 V maximum (DC + peak AC). Input RC approx 1 megohm paralleled by approx 70 pF.

X-Y OPERATION

SINGLE-BEAM CURVE TRACING

100 μV/cm to 20 V/cm calibrated deflection factor in each axis, differential or single-ended input. Panel light indicates upper beam amplifier switched to provide horizontal deflection. X-Y phase difference between amplifiers is ≤1° from DC to 100 kHz, measured at 100 μV/cm.

DUAL-BEAM CURVE TRACING

100 μV/cm to 20 V/cm calibrated vertical deflection factor, separately selectable for upper and lower beams, differential or single-ended input; 0.1 V/cm to 2 V/cm calibrated horizontal deflection factor using external horizontal input common to both beams.

TRIGGER

MODES

Automatic or manual level selection, free run (recurrent). Automatic operation minimizes trigger adjustment for signals of different amplitudes, shapes, and repetition rates. With no input, automatic triggering occurs at an approx 50-Hz rate, providing a convenient reference trace.

COUPLING

AC or DC.

SOURCES

Internal from either amplifier, external, or line. Input R approx 1 megohm.

REQUIREMENTS

INTERNAL

DC: 2 mm, DC to 200 kHz, increasing to 1 cm at 1 MHz.
AC: 2 mm, 50 Hz to 200 kHz, increasing to 1 cm at 1 MHz.

EXTERNAL

DC: 0.5 V to 10 V, DC to 200 kHz, increasing to 2 V to 10 V at 1 MHz.

AC: 0.5 V to 10 V, 50 Hz to 200 kHz, increasing to 2 V to 10 V at 1 MHz.

502A Dual-Beam Oscilloscope RM502A

CRT AND DISPLAY FEATURES

TRONIX DUAL-BEAM CRT

8 x 10-cm display per beam. Separate vertical-deflection plates; common horizontal deflection plates. 2.9-kV accelerating potential. P2 phosphor normally supplied; P1, P7, P11 or P31 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. Z-axis input requires ±25 V peak to peak for beam modulation at normal intensity.

GRATICULE

External; variable edge lighting. 10 x 10-cm display area. Vertical and horizontal centerlines marked in 2-mm divisions.

DISPLAY FEATURES

Pushbutton beam finder for each beam, separate focus for each beam, common intensity, intensity balance.

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR

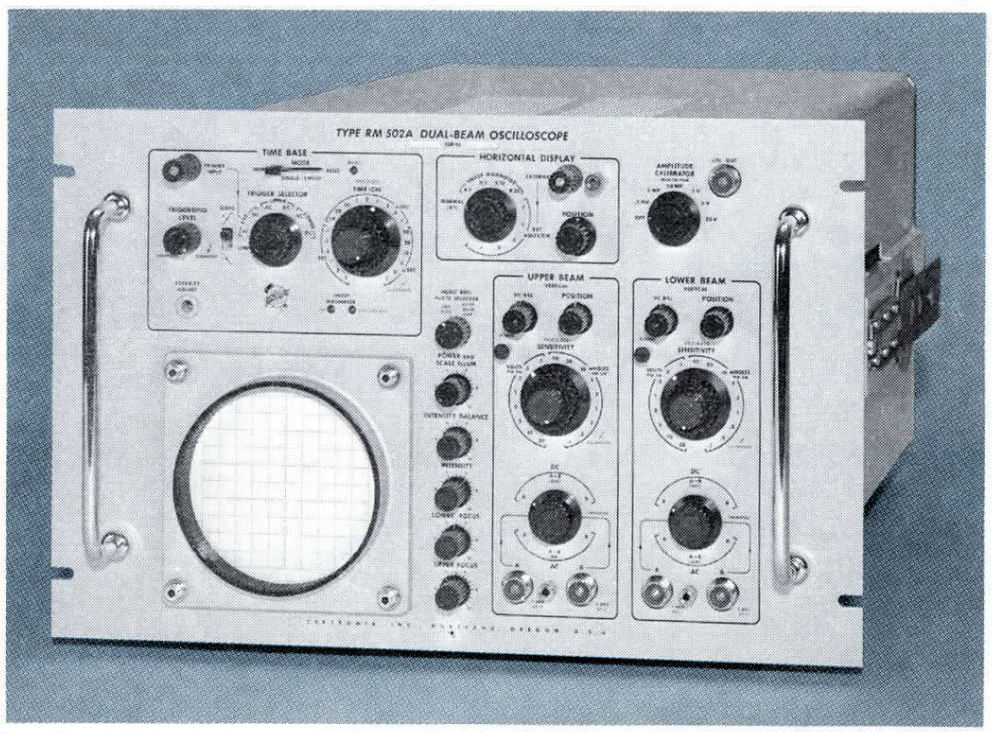
0.5 mV to 50 V in 6 calibrated decade steps, accurate within 3%. 1-kHz ±30% repetition rate.

POWER REQUIREMENT

Wired for 105 to 125 VAC (117-V nominal). Transformer taps permit operation at nominal voltages of 110, 117, 124, 220, 234 and 248 VAC, 50 to 60 Hz. Power consumption 290-W maximum.

CABINET MODEL DIMENSIONS AND WEIGHTS

Height	15⅞ in	40.3 cm
Width	11⅜ in	28.9 cm
Depth	23⅞ in	60.7 cm
Net weight	50¼ lb	22.8 kg
Domestic shipping weight	≈62 lb	≈28.2 kg
Export-packed weight	≈84 lb	≈38.2 kg



RACK MODEL DIMENSIONS AND WEIGHTS

Height	12¼ in	31.1 cm
Width	19 in	48.3 cm
Rack depth	22¾ in	57.8 cm
Net weight	58 lb	26.4 kg
Domestic shipping weight	≈ 97 lb	≈44.1 kg
Export-packed weight	≈117 lb	≈53.2 kg

Type RM502A can be withdrawn from rack on slide-out tracks, tilted and locked in 4 positions.

INCLUDED STANDARD ACCESSORIES

Two P6006 10X probes (010-0125-00), banana-to-banana cable (012-0031-00), two binding-post adapters (013-0004-00), 3 to 2-wire adapter (103-0013-00), 3-conductor power cord (161-0010-03), smoke-gray light filter (378-0567-00); two instruction manuals (070-0382-02). Type RM502A includes in addition one pair mounting tracks (351-0085-00), and mounting hardware.

TYPE 502A OSCILLOSCOPE **$1265**

TYPE RM502A OSCILLOSCOPE **$1365**

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience. The standard 10X probes supplied with the oscilloscope, and the listed optional probes satisfy most measurement requirements. Other probes are available for current and high-voltage measurements. See catalog accessory pages for additional information on these and other items.

SCOPE-MOBILE® CART

Model 202-1: storage drawer and 9-position tilt-lock oscilloscope tray, order 202-1 ..... $145.00

Order tray adapter 040-0365-00 ..... $ 3.00

CAMERAS

C-27-547: f/1.9—1:0.7 lens, Polaroid Land[1] Pack-Film back provides 10 x 10-cm coverage on 3¼ x 4½ film.
Order C-27-547 ..... $480.00

C-27G: f/1.9—1:0.85 lens, no back, provides 10 x 10-cm coverage on 4 x 5 film with optional Graflok[2] back and Polaroid Land film holder $380.00

Graflok back for 4 x 5 film holder (not included).
Order 122-0604-00 ..... $ 50.00

Type 502A to C-27-547 or C-27G Camera adapter, order 016-0225-02 ..... $ 16.00

PROBES

P6023 10X Probe: for more-accurate differential measurements, order 010-0065-00 ..... $ 52.00

P6027 1X Probe, order 010-0070-00 ..... $ 16.50

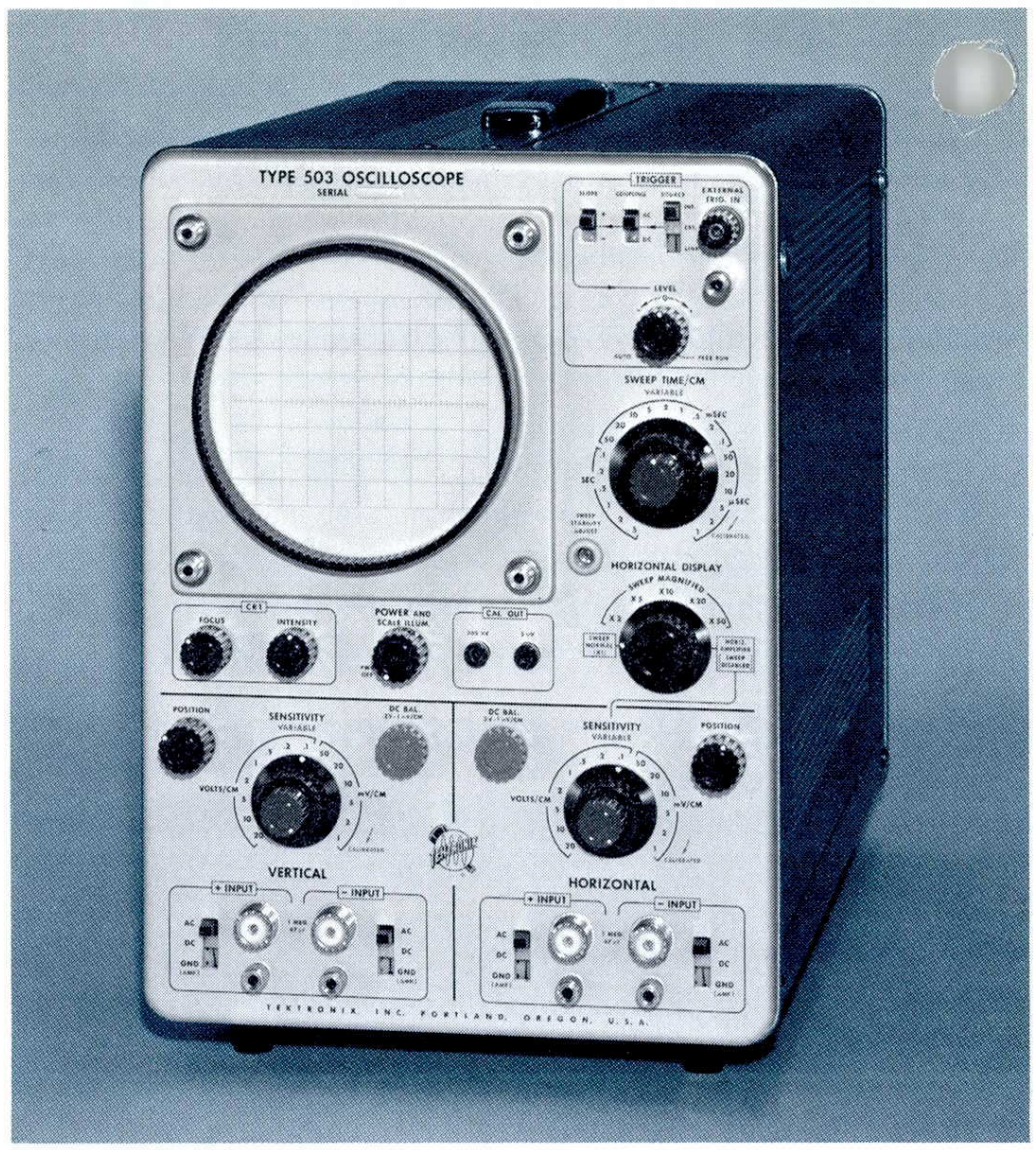
[1] Registered Trademark Polaroid Corporation

[2] Registered Trademark Graflex, Inc.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

503 X-Y Oscilloscope RM503

- ***IDENTICAL VERTICAL & HORIZONTAL AMPLIFIERS***
- ***1 mV DIFFERENTIAL INPUTS***
- ***CABINET OR RACK MODELS***



The Type 503 and RM503 provide accurate measurements and signal-handling versatility in DC-to-450 kHz applications. Differential or single-ended inputs can be used for X-Y displays or conventional time-based displays. Large display area, simple operation, and low cost make the Type 503 ideal for classroom and production-line uses.

The Type RM503, for the same reasons, is ideal for inclusion in a variety of systems, or other monitor applications.

VERTICAL AND HORIZONTAL DEFLECTION

Two identical systems

BANDWIDTH

DC to 450 kHz at 3-dB down. Low-frequency 3-dB point is ≤10 Hz with AC coupling.

DEFLECTION FACTOR

1 mV/cm to 20 V/cm in 14 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to at least 50 V/cm.

INPUT RC

1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE

350 V combined DC + peak AC.

COMMON-MODE REJECTION

From DC to 50 kHz: ≥100:1 at calibrated deflection factors from 1 mV/cm to 0.2 V/cm with 4-V peak to peak input, ≥30:1 at calibrated deflection factors from 0.5 V/cm to 20 V/cm with 40-V peak to peak input (400-V peak to peak from 5 V/cm to 20 V/cm).

PHASE DIFFERENCE IN X-Y MODE

≤1° to 450 kHz at equal calibrated deflection factors from 1 mV/cm to 0.2 V/cm, ≤2° to 50 kHz at equal calibrated deflection factors from 0.5 V/cm to 20 V/cm. Same polarity inputs in both cases.

CHARACTERISTIC SUMMARY

VERTICAL & HORIZONTAL

BANDWIDTH—DC to 450 kHz.

CALIBRATED DEFLECTION FACTOR—1 mV/cm to 20 V/cm.

INPUT RC—1 megohm paralleled by approx 47 pF.

COMMON-MODE REJECTION—100:1 at 1 mV/cm deflection factor. DC to 50 kHz, 4 V P to P, max.

SWEEP GENERATOR

CALIBRATED TIME BASE—1 μs/cm to 5 s/cm.

SWEEP MAGNIFIER—X2, X5, X10, X20, X50.

CRT

DISPLAY AREA—8 x 10 cm.

ACCELERATING VOLTAGE—3 kV.

PHOSPHOR—P2.

OTHER

AMPLITUDE CALIBRATOR—5 mV and 0.5 V, approx 350 Hz squarewave.

POWER REQUIREMENTS—105 to 125 V or 210 to 250 V, 120 watts, max.

HORIZONTAL DEFLECTION

TIME BASE
1 μs/cm to 5 s/cm in 21 calibrated steps (1-2-5 sequence) accurate within 3%. Uncalibrated, continuously variable between steps and to at least 12 s/cm.

MAGNIFIER
X2, X5, X10, X20 or X50 magnification; magnified time base accurate within 5% up to 0.1 μs/cm.

TRIGGER

MODES
Automatic or manual level selection, free run. Automatic operation is useful from 50 Hz to 450 kHz, minimizes trigger adjustment for signals of different amplitudes, shapes, and repetition rates. With no input, automatic triggering occurs at an approx 50-Hz rate, providing a convenient reference trace.

COUPLING
AC or DC.

SOURCES
Internal, external or line.

REQUIREMENTS
½-cm deflection from DC to 50 kHz, increasing to 2-cm deflection at 450 kHz; ½ V external from DC to 450 kHz. Requirements increase below 50 Hz with AC coupling. Automatic operation requires 4/5-cm deflection from 50 Hz to 50 kHz, increasing to 2.5 cm at 450 kHz; ½ V external from 50 Hz to 450 kHz.

CRT

TEKTRONIX CRT
3-kV accelerating potential. P2 phosphor normally supplied, P1, P7, P11, or P31 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. Z-axis input requires ±10 V for CRT modulation at normal intensity.

GRATICULE
External; variable edge lighting. 8 x 10-cm display area. Vertical and horizontal centerlines marked in 2-mm divisions.

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR
5-mV and 500-mV squarewaves, accurate within 3%. 350-Hz ±50% repetition rate.

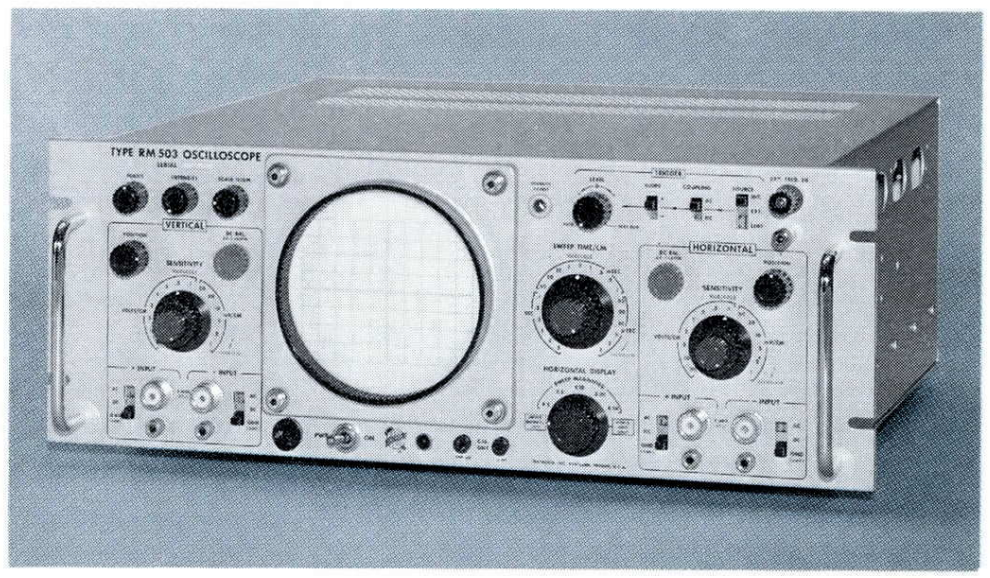
POWER REQUIREMENTS
Wired for 105 to 125 VAC (117-V nominal); transformer taps permit operation from 210 to 250 VAC (234-V nominal); 50 to 60 Hz. Operates from 112 to 132 or 224 to 264 VAC at 400 Hz, 120 to 140 or 240 to 280 VAC at 800 Hz. 120-W maximum power consumption (125 V at 50 Hz).

CABINET MODEL DIMENSIONS AND WEIGHTS

Height	14 11/16 in	37.3 cm
Width	9 3/4 in	24.8 cm
Depth	21 5/8 in	55.0 cm
Net weight	29 1/2 lb	13.4 kg
Domestic shipping weight	≈38 lb	≈17.3 kg
Export-packed weight	≈51 lb	≈23.2 kg

RACK MODEL DIMENSIONS AND WEIGHTS

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Rack depth	17 in	43.2 cm
Net weight	28 lb	12.7 kg
Domestic shipping weight	≈51 lb	≈23.2 kg
Export-packed weight	≈72 lb	≈32.7 kg



RACKMOUNTING
Type RM503 mounts directly to standard 19-inch rack. MOD 171A provides slide-out tracks. Instrument can be conveniently withdrawn, tilted and locked in 7 positions.

INCLUDED STANDARD ACCESSORIES
Two A510 binding-post adapters (013-0004-00); 3 to 2-wire adapter (103-0013-00); smoke-gray filter (378-0567-00); two instruction manuals (070-0218-01). Type RM503 also includes mounting hardware; 3-conductor power cord (161-0024-03); two instruction manuals (070-0314-01).

TYPE 503 OSCILLOSCOPE $695

TYPE RM503 OSCILLOSCOPE $710

TYPE RM503 OSCILLOSCOPE, MOD 171A $760

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

504 450-kHz Oscilloscope RM504

- ***ELECTRONICALLY-REGULATED DC SUPPLIES***
- ***CABINET OR RACK MODELS***

The Type 504 and RM504 provide accurate measurements in DC-to-450 kHz applications. Features include easy-to-use triggering, 1-2-5 sequence on Vertical Sensitivity and Horizontal Time/cm switches, and Calibrator outputs. Large display area, simple operation, and low cost make the Type 504 ideal for classroom and production-line uses.

The Type RM504, for the same reasons, is ideal for inclusion in a variety of systems, or other monitor applications.

VERTICAL DEFLECTION

BANDWIDTH

DC to 450 kHz at 3-dB down. Low-frequency 3-dB point is $\leq$10 Hz with AC coupling. Bandwidth constant at all deflection factors.

DEFLECTION FACTOR

5 mV/cm to 20 V/cm in 12 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to at least 50 V/cm.

INPUT RC

1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE

350 V combined DC + peak AC.

HORIZONTAL DEFLECTION

TIME BASE

1 μs/cm to 0.5 s/cm in 18 calibrated steps (1-2-5 sequence) accurate within 3%. Uncalibrated, continuously variable between steps and to at least 1.2 s/cm.

EXTERNAL INPUT

0.5 V/cm, variable.

TRIGGER

MODES

Automatic or manual level selection, free run. Automatic operation is useful from 50 Hz to 450 kHz, minimizes trigger adjustment for signals of different amplitudes, shapes, and repetition rates. With no input, automatic triggering occurs at an approx 50-Hz rate, providing a convenient reference trace.

COUPLING

AC or DC.

SOURCES

Internal, external or line.

REQUIREMENTS

$\frac{1}{2}$-cm deflection from DC to 50 kHz, increasing to 2-cm deflection at 450 kHz; $\frac{1}{2}$ V external from DC to 450 kHz. Requirements increase below 50 Hz with AC-coupling. Automatic operation requires 4/5-cm deflection from 50 Hz to 50 kHz, increasing to 2.5 cm at 450 kHz; $\frac{1}{2}$ V external from 50 Hz to 450 kHz.

CHARACTERISTIC SUMMARY

VERTICAL

BANDWIDTH—DC to 450 kHz.

CALIBRATED DEFLECTION FACTOR—5 mV/cm to 20 V/cm.

INPUT RC—1 megohm paralleled by approx 47 pF.

HORIZONTAL

CALIBRATED TIME BASE—1 μs/cm to 0.5 s/cm.

EXTERNAL INPUT—0.5 V/cm, variable.

CRT

DISPLAY AREA—8 x 10 cm.

ACCELERATING VOLTAGE—3 kV.

PHOSPHOR—P2.

OTHER

AMPLITUDE CALIBRATOR—25 mV and 0.5 V, approx 350-Hz squarewave.

POWER REQUIREMENTS—105 to 125 V or 210 to 250 V, 115 watts, max.

504 450-kHz Oscilloscope RM504

CRT

TEKTRONIX CRT
5-kV accelerating potential. P2 phosphor normally supplied, P1, P7, P11, or P31 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. Z-axis input requires ±10 V for beam modulation at normal intensity.

GRATICULE
External; variable edge lighting. 8 x 10-cm display area. Vertical and horizontal centerlines marked in 2-mm divisions.

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR
25-mV and 500-mV squarewaves, accurate within 3%. 350 Hz ±50% repetition rate.

POWER REQUIREMENTS
Wired for 105 to 125 VAC (117-V nominal); transformer taps permit operation from 210 to 250 VAC (234-V nominal); 50 to 60 Hz. Operates from 112 to 132 or 224 to 264 VAC at 400 Hz, 120 to 140 or 240 to 280 VAC at 800 Hz. 115-W maximum power consumption (125 V at 50 Hz).

CABINET MODEL DIMENSIONS AND WEIGHTS

Height	$14\frac{11}{16}$ in	37.3 cm
Width	$9\frac{3}{4}$ in	24.8 cm
Depth	$21\frac{5}{8}$ in	55.0 cm
Net weight	$27\frac{1}{2}$ lb	12.5 kg
Domestic shipping weight	≈36 lb	≈16.4 kg
Export-packed weight	≈50 lb	≈22.7 kg

RACK MODEL DIMENSIONS AND WEIGHTS

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Rack depth	17 in	43.2 cm
Net weight	$25\frac{1}{2}$ lb	11.6 kg
Domestic shipping weight	≈49 lb	≈22.3 kg
Export-packed weight	≈69 lb	≈31.4 kg

RACKMOUNTING
Type RM504 mounts directly to standard 19-inch rack. MOD 171A can be withdrawn from rack on slide-out tracks, tilted and locked in 7 positions.

INCLUDED STANDARD ACCESSORIES
A510 binding-post adapter (013-0004-00); 3 to 2-wire adapter (103-0013-00); smoke-gray filter (378-0567-00); two instruction manuals (070-0224-00). Type RM504 also includes mounting hardware; 3-conductor power cord (161-0024-03); two instruction manuals (070-0315-00).

TYPE 504 OSCILLOSCOPE $595
TYPE RM504 OSCILLOSCOPE $605
TYPE RM504 OSCILLOSCOPE, MOD 171A $655

OPTIONAL ACCESSORIES

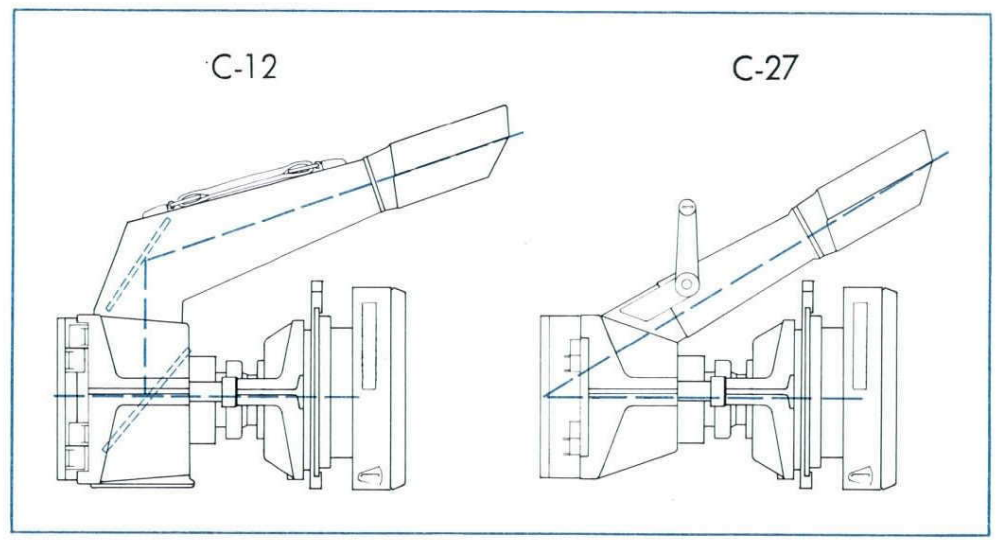
PROBES
P6006 10X Probe Package, order 010-0125-00 ..... $ 29.00
P6007 100X Probe Package, order 010-0134-00 ..... $ 29.00
P6027 1X Probe Package, order 010-0070-00 ..... $ 16.50

SCOPE-MOBILE® CART

Model 201-1: storage drawer and 9-position tilt-lock oscilloscope tray, order 201-1 ..... $145.00

SLIDE-OUT TRACKS
Convert standard Type RM504 to MOD 171A, provide easy withdrawal and tilt of instrument, order 351-0050-00 $ 50.00

CAMERAS



Standard C-12 provides no-parallax viewing, f/1.9-1:0.85 lens, Polaroid Land* Pack Film back, order C-12 ..... $490.00

Type 504 or RM504 to C-12 Camera adapter.
Order 016-0226-01 ..... $ 16.00

Standard C-27 has rotating and removable viewing hood allowing mounting on adjacent Type RM504's, f/1.9-1:0.85 lens. Polaroid Land Pack Film back, order C-27 ..... $460.00

Type 504 or RM504 to C-27 Camera adapter.
Order 016-0225-02 ..... $ 16.00

*Registered Trademark, Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

515A 15-MHz Oscilloscope RM15

- ***50-mV/cm DEFLECTION FACTOR***
- ***INTERNAL DELAY LINE***
- ***TWO INPUTS, SELECTABLE FROM THE FRONT PANEL***

The Tektronix Type 515A is a DC-coupled general purpose cathode-ray oscilloscope combining reliable circuitry in an easy-to-use, compact instrument. Wide time-base range, broad bandwidth characteristics, and calibrated deflection factor make the Type 515A well suited for general-purpose laboratory work and production-line testing applications.

VERTICAL DEFLECTION

BANDWIDTH
DC to 15 MHz at 3-dB down. Low-frequency 3-dB-down point is approx 2 Hz with AC coupling, approx 0.2 Hz with included 10X probe.

RISETIME
24 ns.

DEFLECTION FACTOR
50 mV/cm to 20 V/cm in 9 calibrated steps, 1-2-5 sequence. All steps accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/cm. Warning light indicates uncalibrated setting.

INPUT RC
1 megohm paralleled by approx 36 pF.

MAXIMUM INPUT VOLTAGE
600 V combined DC and peak AC.

SIGNAL INPUTS
Two manually-selected signal inputs with approx 60-dB isolation.

DELAY LINE
Permits viewing of leading edge of triggering waveform.

HORIZONTAL DEFLECTION

TIME BASE
0.2 μs/cm to 2 s/cm in 22 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 5 s/cm. Warning light indicates uncalibrated setting.

X5 MAGNIFIER
Operates over full time base, increases fastest rate to 40 ns/cm. Accuracy of magnified time base is within 5%. A neon light indicates when the magnifier is in use.

CHARACTERISTIC SUMMARY

VERTICAL

BANDWIDTH—DC to 15 MHz.

RISETIME—24 ns.

CALIBRATED DEFLECTION FACTOR—50 mV/cm to 20 V/cm.

INPUT RC—1 megohm paralleled by approx 36 pF.

HORIZONTAL

CALIBRATED TIME BASE—0.2 μs/cm to 2 s/cm.

X5 MAGNIFIER—Operates over full time base, increases fastest rate to 40 ns/cm.

EXTERNAL INPUT—1.4 V/cm to approx 25 V/cm. DC to 500 kHz at 1.4 V/cm.

CRT

DISPLAY AREA—6 x 10 cm.

ACCELERATING VOLTAGE—4 kV.

PHOSPHOR—P31.

OTHER

AMPLITUDE CALIBRATOR—50 mV to 100 V, approx 1-kHz squarewave.

POWER REQUIREMENTS—105 to 125 V or 210 to 250 V, 50 to 60 Hz, approx 300 W.

EXTERNAL INPUT

Variable between approx 1.4 V/cm to 25 V/cm. DC to 500 kHz at 1.4 V/cm (3-dB-down).

OTHER

Gate output: positive-going rectangular pulse with same duration as time base; approx 20-V amplitude.

Sawtooth output: positive-going ramp with same duration as time base; approx 150-V amplitude.

TRIGGER

MODES

Manual level selection; Automatic; Preset Stability; HF SYNC. Automatic triggering may be used for signal repetition rates between approx 50 Hz to 2 MHz, eliminating the need for re-adjusting TRIGGERING LEVEL while sequentially viewing signals of different amplitudes, shapes, and repetition rates. With no input, automatic triggering occurs at an approx 50-Hz rate, providing a convenient reference trace. HF SYNC assures a steady display of sinewave signals up to approx 20 MHz.

COUPLING

DC or AC.

SOURCES

Internal; External; or Line.

REQUIREMENTS

AC coupling requires 2-mm deflection (internal) or 0.5 V external at 1 kHz, increasing to 5-mm deflection or 1.5 V external at 2 MHz; low-frequency response is 3-dB down at approximately 16 Hz. DC coupling requires 5-mm deflection (internal) or 0.5 V external from DC to 1 kHz, increasing to 2-cm deflection or 1.5 V external at 2 MHz. Automatic triggering requires 5-mm deflection (internal) or 1 V external from 50 Hz to 1 kHz, increasing to 1-cm deflection or 3 V external at 2 MHz. HF sync requires 2-cm deflection or 2 V external at 20 MHz.

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR

Approx 1-kHz squarewave; 50 mV to 100 V peak to peak in 11 steps (1-2-5 sequence); accurate within 3%.

TEKTRONIX CRT

Round, 5-inch, flat-faced tube with helical post-accelerating anode. 4-kV accelerating potential. Edge-lighted graticule is scaled with 6 vertical and 10 horizontal centimeter divisions. P31 phosphor normally supplied, P1, P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. Z-axis input (515A only): AC-coupled to CRT cathode: 15 nF, 27 kΩ. Positive signal of 5 V will provide adequate blanking of trace at moderate intensity setting. Maximum recommended drive is ±20 V.

DIMENSIONS AND WEIGHTS

Height	$14\frac{1}{16}$ in	35.7 cm
Width	$9\frac{3}{4}$ in	24.8 cm
Depth	$21\frac{13}{16}$ in	55.4 cm
Net weight	42 lb	19.1 kg
Domestic shipping weight	≈51 lb	≈23.2 kg
Export-packed weight	≈64 lb	≈29 kg

POWER REQUIREMENTS

105 V to 125 V or 210 V to 250 V, 50 to 60 Hz, wired for 117 V center. Instrument can be ordered wired for operation on any line voltage listed below. Power consumption is approx 300 watts.

Changing taps insures regulation as follows:

110	99 to 117 volts	220	198 to 235 volts
117	105 to 125 volts	234	210 to 250 volts
124	111 to 132 volts	248	223 to 265 volts

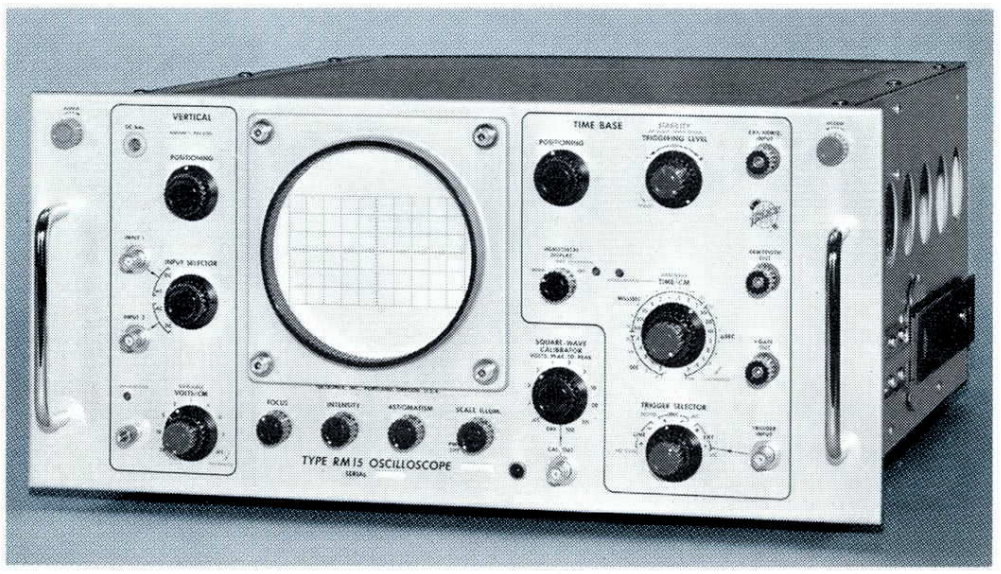
INCLUDED STANDARD ACCESSORIES

P6006 10X probe package (010-0127-00); 3 to 2-wire adapter (103-0013-00); 3-conductor power cord (161-0010-03); smoke gray filter (378-0567-00); patch cord, BNC-to-BNC, 18 inch (012-0087-00); patch cord, BNC-to-banana plug, 18 inch (012-0091-00); post jack, BNC (012-0092-00); two instruction manuals (070-0247-01).

TYPE 515A OSCILLOSCOPE $1050

RACKMOUNT OSCILLOSCOPE

The Type RM15 is a mechanically rearranged Type 515A Oscilloscope. It mounts in a standard 19-inch rack on slide-out tracks. It can be pulled forward, tilted, and locked in any of seven positions for servicing convenience. Except for no Z-axis input, electrical characteristics of Type RM15 are the same as described for Type 515A Oscilloscope.



DIMENSIONS AND WEIGHTS

Height	$8\frac{3}{4}$ in	22.2 cm
Width	19 in	48.2 cm
Depth	$22\frac{11}{16}$ in	57.8 cm
Net weight	42 lb	19.1 kg
Domestic shipping weight	≈76 lb	≈34.6 kg
Export-packed weight	≈96 lb	≈43.6 kg

INCLUDED STANDARD ACCESSORIES

Type RM15 includes accessories listed for Type 515A plus one pair mounting tracks (351-0085-00). Part number for two included instruction manuals is (070-0242-00).

TYPE RM15 OSCILLOSCOPE $1125

OPTIONAL ACCESSORIES

Optional accessories serve to extend the usefulness of the Type 515A and Type RM15 in certain applications. This listing covers only the more commonly used items. The standard probe (10X) supplied with the instrument satisfies most measurement requirements; optional probes may be better suited for particular applications. In addition to the listed optional probes, other probes are available for current and high-voltage measurements. A complete list of accessory items can be found in the catalog accessory pages.

CRADLE ASSEMBLY

When the Type RM15 is used in a backless rack, these supporting cradles are necessary for rear slide support.
Order 040-0344-00 ..... $ 10.00

SCOPE-MOBILE® CART

Type 201-1 Scope-Mobile® Cart features tilt locking in any of nine positions for convenience in viewing Type 515A. 5-inch rubber wheels permit easy transport between locations. Order Type 201-1 ..... $145.00

DUST COVER

Provides protection for Type 515A during transport or s[illegible] age. Made of waterproof blue vinyl with a clear fro[illegible] area for easy identification of the instrument.
Order 016-0067-00 ..... $ 8.00

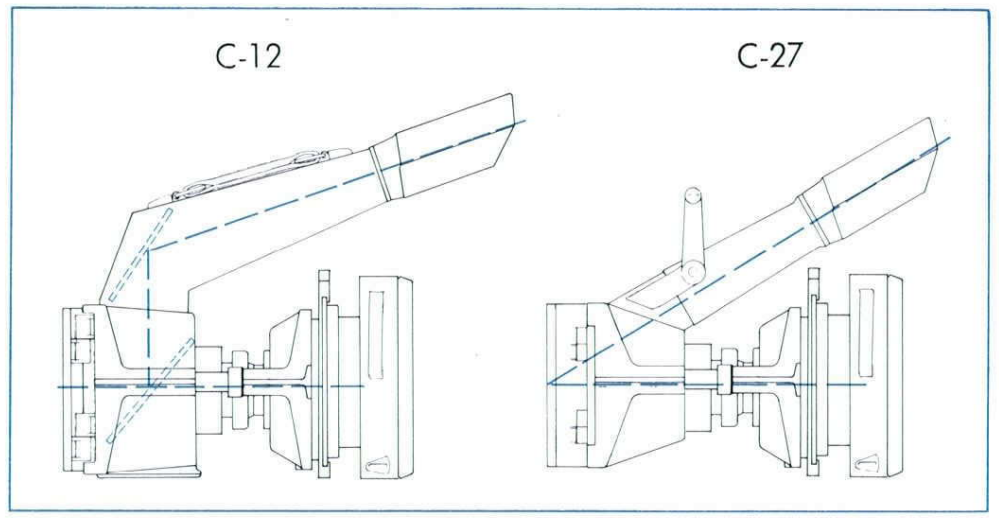
POLARIZED VIEWER

The polarized viewer reduces troublesome reflections and glare under high ambient-light conditions. Order 016-0053-00 ..... $ 12.00

VIEWING HOOD

Includes molded rubber eyepiece and separate tubular light shield. Order 016-0001-01 ..... $ 7.00

CAMERAS



Standard C-12 provides no-parallax viewing, f/1.9-1:0.85 lens, Polaroid Land* Pack Film back, order C-12 ..... $490.00

Type 515 or RM15 to C-12 Camera adapter.
Order 016-0226-01 ..... $ 16[illegible]

Standard C-27 has rotating and removable viewing hood allowing mounting on adjacent Type RM15's, f/1.9-1:0.85 lens, Polaroid Land Pack Film back, order C-27 ..... $460.00

Type 515 or RM15 to C-27 Camera adapter.
Order 016-0225-02 ..... $ 16.00

PROBES

P6007 100X Probe Package, order 010-0150-00 ..... $ 29.00

P6028 1X Probe Package, order 010-0074-00 ..... $ 16.50

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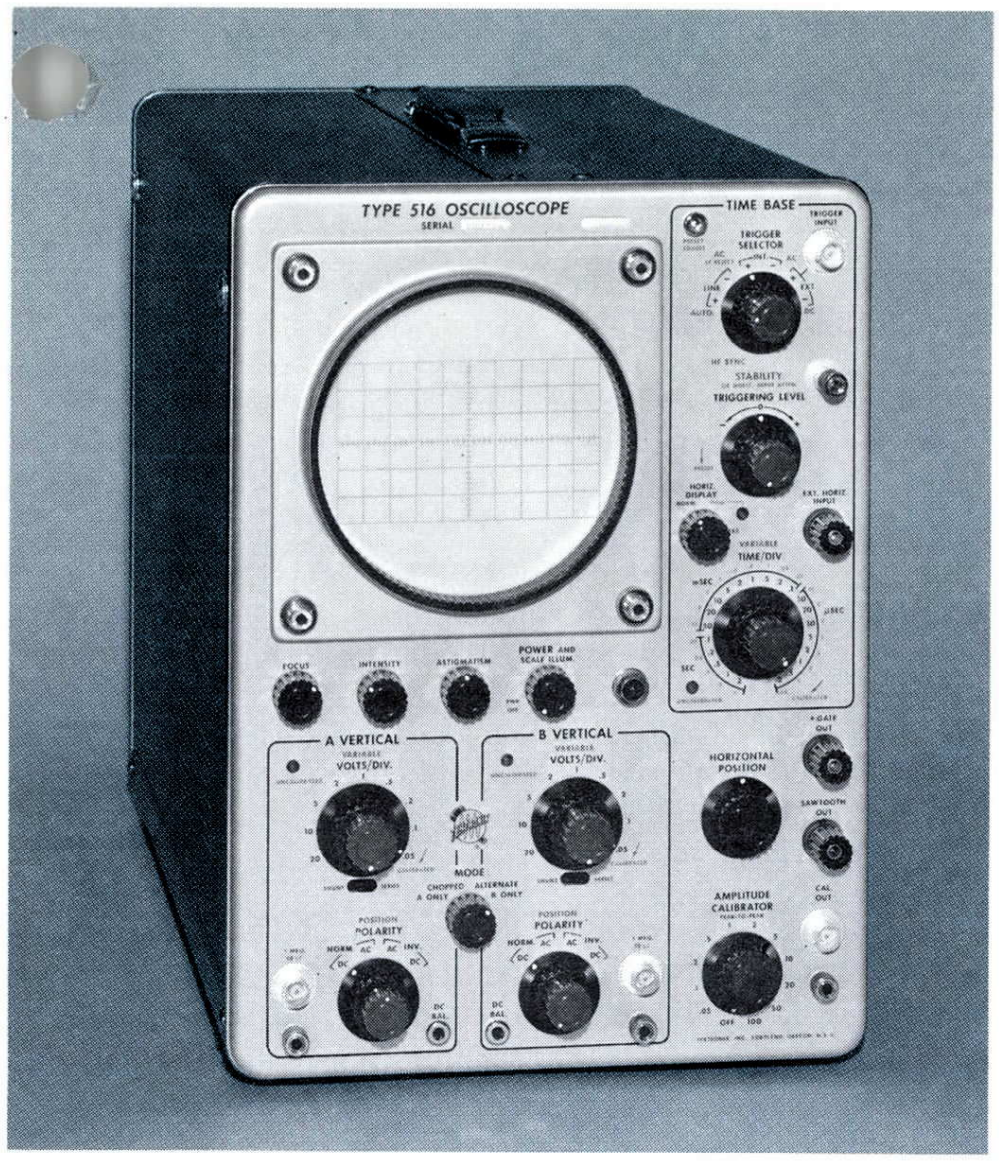
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

15-MHz Dual-Trace Oscilloscope

516



- *50-mV/cm DEFLECTION FACTOR*
- *2 IDENTICAL INPUT CHANNELS*
- *CHOPPED OR ALTERNATE SWITCHING*

The Type 516 is a dual-trace, semi-portable instrument ideally suited to bench work applications. Vertical calibrated deflection factor is 0.05 V/cm for each channel, with four operating modes. The Type 516 provides small size and light weight combined with simple operation and reliable performance making it suitable for many laboratory and field applications.

VERTICAL DEFLECTION

(2 Identical Channels)

BANDWIDTH
DC to 15 MHz at 3-dB down. Low-frequency 3-dB-down point is approx 2 Hz with AC coupling, approx 0.2 Hz with included 10X probe.

RISETIME
24 ns.

DEFLECTION FACTOR
50 mV/cm to 20 V/cm in 9 calibrated steps, 1-2-5 sequence. All steps accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/cm. Warning light indicates uncalibrated setting.

INPUT RC
1 megohm paralleled by approx 20 pF.

MAXIMUM INPUT VOLTAGE
600 V combined DC and peak AC.

OPERATING MODES
Channel A only; Channel B only; Alternate; Chopped; 3.3-μs segments of each channel are displayed (chopping rate 150 kHz). Chopped transient blanking is provided. Polarity; either channel may be operated as normal or inverted.

SIGNAL DELAY
Permits viewing the leading edge of waveform.

HORIZONTAL DEFLECTION

TIME BASE
0.2 μs/cm to 2 s/cm in 22 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 6 s/cm. Warning light indicates uncalibrated setting.

X5 MAGNIFIER
Operates over full time base, increases fastest rate to 40 ns/cm. Accuracy of magnified time base is within 5%. A neon light indicates when the magnifier is in use.

CHARACTERISTIC SUMMARY

VERTICAL

(2 Identical Channels)

BANDWIDTH—DC to 15 MHz.

RISETIME—24 ns.

CALIBRATED DEFLECTION FACTOR—50 mV/cm to 20 V/cm.

INPUT RC—1 megohm paralleled by approx 20 pF.

HORIZONTAL

CALIBRATED TIME BASE—0.2 μs/cm to 2 s/cm.

X5 MAGNIFIER—Operates over full time base, increases fastest rate to 40 ns/cm.

EXTERNAL INPUT—1.5 V/cm to approx 25 V/cm. DC to 500 kHz at 1.5 V/cm.

CRT

DISPLAY AREA—6 x 10 cm.

ACCELERATING VOLTAGE—4 kV.

PHOSPHOR—P31.

OTHER

AMPLITUDE CALIBRATOR—50 mV to 100 V, approx 1-kHz squarewave.

POWER REQUIREMENTS—105 to 125 V or 210 to 250 V, 50 to 60 Hz, approx 300 W.

EXTERNAL INPUT

Variable between approx 1.5 V/cm to 25 V/cm. DC to 500 kHz at 1.5 V/cm (3-dB-down).

OTHER

Gate output: positive-going rectangular pulse with same duration as time base; approx 25-V amplitude.

Sawtooth output: positive-going ramp with same duration as time base; approx 150-V amplitude.

TRIGGER

MODES

Manual level selection; Automatic; Preset Stability; HF SYNC. Automatic triggering may be used for signal repetition rates between approx 60 Hz to 2 MHz, eliminating the need for readjusting TRIGGERING LEVEL while sequentially viewing signals of different amplitudes, shapes, and repetition rates. With no input, automatic triggering occurs at an approx 50-Hz rate, providing a convenient reference trace. HF SYNC assures a steady display of sinewaves to approx 20 MHz.

COUPLING

AC, DC, or AC LF reject.

SOURCES

Internal; External; or Line.

REQUIREMENTS

AC coupling requires 2-mm deflection (internal) or 0.5 V external at 1 kHz, increasing to 5-mm deflection or 1.5 V external at 2 MHz; low-frequency response is 3-dB down at approximately 16 Hz. AC low-frequency reject attenuates frequencies below 16 kHz. DC coupling requires 5-mm deflection (internal) or 0.5 V external from DC to 1 kHz, increasing to 2-cm deflection or 1.5 V external at 2 MHz. Automatic triggering requires 5-mm deflection (internal) or 1 V external from 50 Hz to 1 kHz, increasing to 1-cm deflection or 3 V external at 2 MHz. HF sync requires 2-cm deflection or 2 V external at 20 MHz.

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR

Approx 1-kHz squarewave; 50 mV to 100 V peak to peak in 11 steps (1-2-5 sequence); accurate within 3%.

TEKTRONIX CRT

Round, 5-inch, flat-faced tube with helical post-accelerating anode. 4-kV accelerating potential. Edge-lighted graticule is scaled with 6 vertical and 10 horizontal centimeter divisions. P31 phosphor normally supplied; P1, P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. A rear panel switch provides blanking voltage to eliminate switching transients when operating in the chopped mode. External terminal permits Z-axis modulation AC coupled to the cathode.

DIMENSIONS AND WEIGHTS

Height	$14\frac{1}{16}$ in	35.7
Width	$9\frac{3}{4}$ in	24.8
Depth	$21\frac{13}{16}$ in	55.4 cm
Net weight	$43\frac{1}{2}$ lb	19.8 kg
Domestic shipping weight	≈53 lb	≈24.1 kg
Export-packed weight	≈66 lb	≈30 kg

POWER REQUIREMENTS

105 V to 125 V or 210 V to 250 V, 50 to 60 Hz, wired for 117 V center. Power consumption is approx 300 watts. Changing taps insures regulation as follows:

110	99 to 117 volts	220	198 to 235 volts
117	105 to 125 volts	234	210 to 250 volts
124	111 to 132 volts	248	223 to 265 volts

INCLUDED STANDARD ACCESSORIES

Two P6006 probe packages (010-0127-00); 3 to 2-wire adapter (103-0013-00); 3-conductor power cord (161-0010-03); Smoke-gray filter (378-0567-00); Patch cord, BNC-to-BNC, 18 inch (012-0087-00); Patch cord, BNC-to-banana plug, 18 inch (012-0091-00); Post jack, BNC (012-0092-00); two instruction manuals (070-0225-01).

TYPE 516 OSCILLOSCOPE $1275

OPTIONAL ACCESSORIES

Optional accessories extend the usefulness of the Type 516 in certain applications. The standard 10X probes supplied with the instrument satisfy most measurement requirements. Listed optional probes may be better suited for particular applications. Other probes are available for current and high-voltage measurements. A complete list of accessory items can be found in the catalog accessory pages.

RACKMOUNT ADAPTER

Consists of a cradle to support the Type 516 in any standard 19-inch relay rack, and a mask to fit around the regular instrument panel. Rack height requirement is $15\frac{3}{4}$ inches, order 040-0277-00 . . . . . $ 34.50

SCOPE-MOBILE® CART

Model 201-1: tilt locking in any of nine positions for convenience in viewing Type 516. 5-inch rubber wheels permit easy transport between locations, order 201-1 . . . . . $145.00

C-12 CAMERA

f/1.9, 1:0.85 lens; Polaroid Land* Pack-Film Back. Beam-splitting mirror provides on-axis binocular view of the CRT display, eliminating parallax, order C-12 . . . . . $490.00

C-12 Camera adapter, order 016-0226-01 . . . . . $ 16.00

PROBES

P6007 100X Probe Package, order 010-0150-00 . . . . . $ 29.00

P6028 1X Probe Package, order 010-0074-00 . . . . . $ 16.50

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U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Portable Oscilloscope Reference & Contents

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No longer need measurements be compromised due to adverse field conditions. Combining easy portability with high performance, even under rugged conditions, these compact portable oscilloscopes are ideally suited for the requirements of the engineer in the field. They can be used for such work as testing and servicing high-speed computers, telemetering equipment, and for other "on-site" maintenance applications where space for test-instrumentation is limited. Laboratory oscilloscope performance with sharp, bright displays are provided for field-site applications.

Portable Oscilloscope Reference

Tektronix portable instruments provide performance and convenience features which span a wide variety of oscilloscope applications. The portable family of instruments is designed to permit you to choose the instrument that best suits your application.

Laboratory Portables

The Types 310A and 317 are well suited to such applications as maintenance of numerical controlled machines. These instruments are low-cost, AC-operated, laboratory oscilloscopes that are easily transportable and occupy little bench space.

Rugged Portables

The balance of the family (Types 321A, 323, 422, 453, and 454) are solid-state instruments that combine small size, light weight and the ability to make precision waveform measurements. These instruments are mechanically designed to withstand the shock, vibration, and other extremes of environment associated with portability. Bandwidths to 150 MHz, dual-trace vertical amplifiers, delaying sweep, and AC, DC, or battery operation are some of the features.

The obvious advantages of the portable instruments are small size, light weight, and less capital outlay for a given gain-bandwidth capability. One of the less obvious details, such as environmental characteristics, has been given no less amount of consideration.

The environmental characteristics of these instruments allow them to operate over a temperature range of −15°C to +55°C and be stored for long periods of time from −55°C to +75°C. For those instruments including batteries the storage temperatures are limited to −40°C to +60°C.

These environmentalized instruments will operate at an altitude of 15,000 feet, but can be carried, non-operating, to altitudes as high as 50,000 feet. The effects of high humidity have been minimized since these instruments meet 5 cycles of a test as defined by MIL STD 202C method 106B. Non-nutrient materials are used where possible.

These instruments will withstand vibration for 15 minutes along each of the three major axes, 0.025 inches peak-to-peak displacement (4 g's at 55 c/s) 10 to 55 to 10 c/s in one-minute cycles, while operating. They will also withstand shock of 30 g's, half sine, 11-ms duration, two shocks per axis in each direction for a total of 12 shocks, operating or non-operating.

Electromagnetic interference (EMI) rears its head in both laboratory and field applications which affect either the system under test or the testing instrument. These portable instruments, with the exception of the Type 321A, have been subjected to tests as specified in MIL I 6181D where EMI radiated from the instrument is held within the given limits from 150 kHz to 1 GHz. EMI conducted out of the instrument through the power cord is held within the given limits from 150 kHz to 25 MHz.

Physical design enters into the usability of these instruments. With the adjustable handle locked in the carry position, the Type 323, 422, 453 and 454 present a vertical form factor which enables them to be carried at the side using only one hand. The handle rotates to other fixed positions providing a convenient lift stand for bench applications. A front cover prevents accidental damage to the operating controls and seals out dust and moisture while in transit. The cover also provides convenient storage for standard accessories. Rain covers are provided to protect these instruments from the elements. These compact, high-performance instruments are light weight and their small size enables them to fit into small places, such as under the seat of an airplane.

Battery Operation

Three of these instruments (Types 321A, 323, and 422) may be battery operated. Battery operation provides compact, lightweight instruments which a user may move from one remote location to another without concern for power connections. They are especially well suited for maintenance of remote microwave installations, mobile communications equipment, aircraft and marine instrumentation, production control equipment, etc.

The nickel cadmium battery cells used in Tektronix instruments have been selected as a result of extensive evaluation. Each battery cell in the battery pack receives an ampere-hour test, has met or exceeds the ampere-hour storage requirement and has been rigidly inspected. The battery cells used in the battery pack should provide a useful operating life extending over several hundred charge-discharge cycles.

Gas evolution and recombination take place during battery charging. This creates a pressure within the cells which they normally can withstand. If a cell becomes defective or a circuit failure causes the recommended charge rate to be exceeded, excessive pressure builds up. The pressure may rupture a relief valve, exhausting the gas. This action may shorten the life of the cell and will coat the surrounding areas with a corrosive substance. Individual cells or the entire battery should be replaced if venting or excessive corrosion has occurred.

If one cell is defective and fails while the rest of the battery is quite new, that cell may be replaced without undue concern. Introducing a strong cell into a weak battery or a weak cell into a strong battery will precipitate reverse charging of the weakest cells. It is possible for the unbalance to become so great that during discharge, the weak cells completely lose their charge and then become reverse-charged by the current from the strong cells. If NiCd cells become reverse charged, their ability to be recharged can be impaired or destroyed.

During normal usage or storage, the individual battery cells in the battery pack acquire slightly different charge characteristics. To provide the best overall operation and maximum operating life, the charge on the individual battery cells should be equalized periodically. This can be done without damage to the cells by charging the battery at the full charge rate for 24 hours. This should be done after every 15 charge-discharge cycles or every 30 days, whichever occurs first. Although partial recharging of NiCd batteries is not recommended as a common practice, occasional partial recharges can be tolerated. About 30 to 45 minutes of operating time can be expected as a result of a 1-hour charge period.

Charge retention characteristics of nickel cadmium batteries vary with storage temperature and humidity. Battery packs may be stored at ambient temperatures between −40°C and +60°C without damage, either in the instrument or as a separate unit. However, the self-discharge rate increases with ambient temperature, for example cells stored at +20°C will lose about 50% of their stored charge in three months, but when stored at +50°C they will be almost completely self discharged in only one month.

For best shelf life when storing the battery pack for long periods of time, fully recharge the battery pack about every three months. If the battery pack must be stored at either high-ambient temperature or high humidity for an extended period of time, it is recommended that the battery pack be continuously trickle charged after an initial full recharge.

4-MHz Portable Oscilloscope

310A

- ***SMALL SIZE—LIGHT WEIGHT***
- ***4-MHz BANDWIDTH***
- ***10-mV/DIV DEFLECTION FACTOR***

The Type 310A Oscilloscope is an instrument you can take with you—easily, comfortably. Small size and low weight combined with operation on 50- to 800-hertz line frequency make this an ideal instrument for maintenance and calibration of specialized measuring and recording instruments at their point of use. Accurate calibration and excellent linearity assure precise time and amplitude measurements either in the laboratory or in the field. Panel design and controls contribute to operator convenience.

VERTICAL DEFLECTION

BANDWIDTH

DC to 4 MHz at 3-dB down to 0.1 V/div, 2 Hz to 3.5 MHz at 3 dB down to 10 mV/div. Low-frequency 3 dB down point, AC coupled: 2 Hz, 0.2 Hz with included 10X probe.

RISETIME

≈90 ns to 0.1 V/div; ≈100 ns to 10 mV/div.

DEFLECTION FACTOR

10 mV/div to 50 V/div in 12 calibrated steps (1-2-5 sequence), accurate within 3%. AC coupled at 10 mV/div to 50 mV/div. Uncalibrated, continuously variable between steps and to approx 125 V/div. Warning light indicates uncalibrated setting.

INPUT RC

1 megohm paralleled by approx 40 pF.

HORIZONTAL DEFLECTION

TIME BASE

0.5 μs/div to 0.2 s/div in 18 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 0.6 s/div. Warning light indicates uncalibrated setting.

X5 MAGNIFIER

Operates over full time base, increases fastest rate to 0.1 μs/div. Magnified time base accurate within 4% (5% at 0.1 μs/div).

EXTERNAL INPUT

1.5 V/div, adjustable. DC to 500 kHz at —3 dB. Input R approx 100 kΩ.

CHARACTERISTIC SUMMARY

VERTICAL

BANDWIDTH—0.1 V/div to 50 V/div, DC to 4 MHz. 10 mV/div to 50 mV/div, 2 Hz to 3.5 MHz.

RISETIME—90 ns to 0.1 V/div, 100 ns to 10 mV/div.

CALIBRATED DEFLECTION FACTOR
DC-coupled, 0.1 V/div to 50 V/div.
AC-coupled only, 10 mV/div to 50 mV/div.

INPUT RC—1 megohm paralleled by approx 40 pF.

HORIZONTAL

CALIBRATED TIME BASE—0.5 μs/div to 0.2 s/div.

X5 MAGNIFIER—Extends time base to 0.1 μs/div.

EXTERNAL INPUT—1.5 V/div, DC to 500 kHz.

CRT

DISPLAY AREA—8 x 10 div. Each div equal to 1/4 inch.

ACCELERATING VOLTAGE—1.85 kV.

PHOSPHOR—P31.

OTHER

AMPLITUDE CALIBRATOR—50 mV to 100 V, approx 1-kHz squarewave.

POWER REQUIREMENTS—105 to 125 V or 210 to 250 V, 175 watts.

TRIGGERING

MODES
Manual or automatic. Automatic operation is useful between approx 60 Hz and 2 MHz, minimizes trigger adjustment for signals of different amplitudes, shapes and repetition rates. With no input, automatic triggering occurs at an approx 50-Hz rate, providing a convenient reference trace.

COUPLING
AC or DC.

SOURCES
Internal, external, or line.

REQUIREMENTS
0.25-div deflection or 0.2 V external from DC to 1 kHz, increasing to 2-div deflection or 2 V external at 5 MHz. AC coupling response —3 dB at 16 Hz. Automatic operation requires 0.25 div deflection or 0.2 V external from 60 Hz to 1 kHz, increasing to 2-div deflection or 2.0 V external at 2 MHz.

CRT

TEKTRONIX CRT
8 x 10-div display area; each div is 1/4 inch. 3-inch tube operates at 1.85-kV accelerating voltage. P31 phosphor normally supplied; P1, P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. Z-axis input is AC coupled to CRT cathode, requires 20 V peak to peak for beam modulation at normal intensity.

GRATICULE
External; variable edge lighting. Vertical and horizontal centerlines marked in 5 minor divisions per major 1/4-inch division.

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR
50 mV to 100-V squarewave, 11 calibrated steps (1-2-5 sequence), accurate within 3%. Approx 1-kHz repetition rate.

POWER REQUIREMENTS
Wired for 105 to 125 VAC (117-V nominal). Transformer taps permit operation at nominal voltages of 110, 117, 124, 220, 234 and 248 VAC, 50 to 800 Hz (requires approx 4% higher line voltage at 800 Hz). Power consumption approx 175 W. Can be factory wired for any of the above nominal voltages, if so indicated on order.

DIMENSIONS AND WEIGHTS

Height	$10\frac{7}{8}$ in	27.6 cm
Width	$6\frac{15}{16}$ in	17.6 cm
Depth	$17\frac{11}{16}$ in	44.9 cm
Net weight	$23\frac{1}{2}$ lb	10.7 kg
Domestic shipping weight	≈30 lb	≈13.6 kg
Export-packed weight	≈38 lb	≈17.3 kg

INCLUDED STANDARD ACCESSORIES
P6012 probe (010-0203-00); 18-inch BNC-to-BNC patch cord (012-0087-00); 18-inch BNC-to-banana plug patch cord (012-0091-00); BNC post jack (012-0092-00); 3-conductor power cord (161-0024-03); 3 to 2-wire adapter (103-0013-00); smoke-gray filter (378-0550-00); two instruction manuals (070-0893-00).

TYPE 310A OSCILLOSCOPE $795

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability provide added convenience. The standard probe supplied with the instrument satisfies most measurement requirements; optional probes may be better suited for particular applications. See catalog accessory pages for additional information on these and other items.

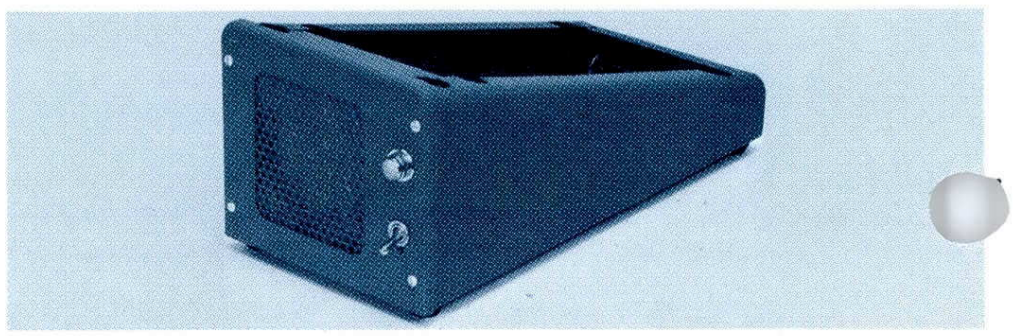
CARRYING CASE
Protects Type 310A, provides convenient accessory storage compartment, order 016-0028-01 . . . . . $22

C-30A COMPACT CAMERA
f/1.9 lens, magnification variable from 1.5:1 to 0.7:1, Polaroid Land* Pack-Film back for 3000-speed film, order C-30A-P $480.00
Type 310A to C-30A Camera adapter, order 016-0241-00 $16

C-30A CAMERA CARRYING CASE
Constructed of heavy-gage, high-impact plastic, has foam-backed, vacuum-formed styrene liner. Holds C-30A Camera, all standard accessories and extra film.
Order 016-0126-00 . . . . . $38

PROBES
P6007 100X Probe Package, order 010-0150-00 . . . . . $29
P6011 1X Miniature Probe Package, order 010-0193-00 . . $21

FAN BASE

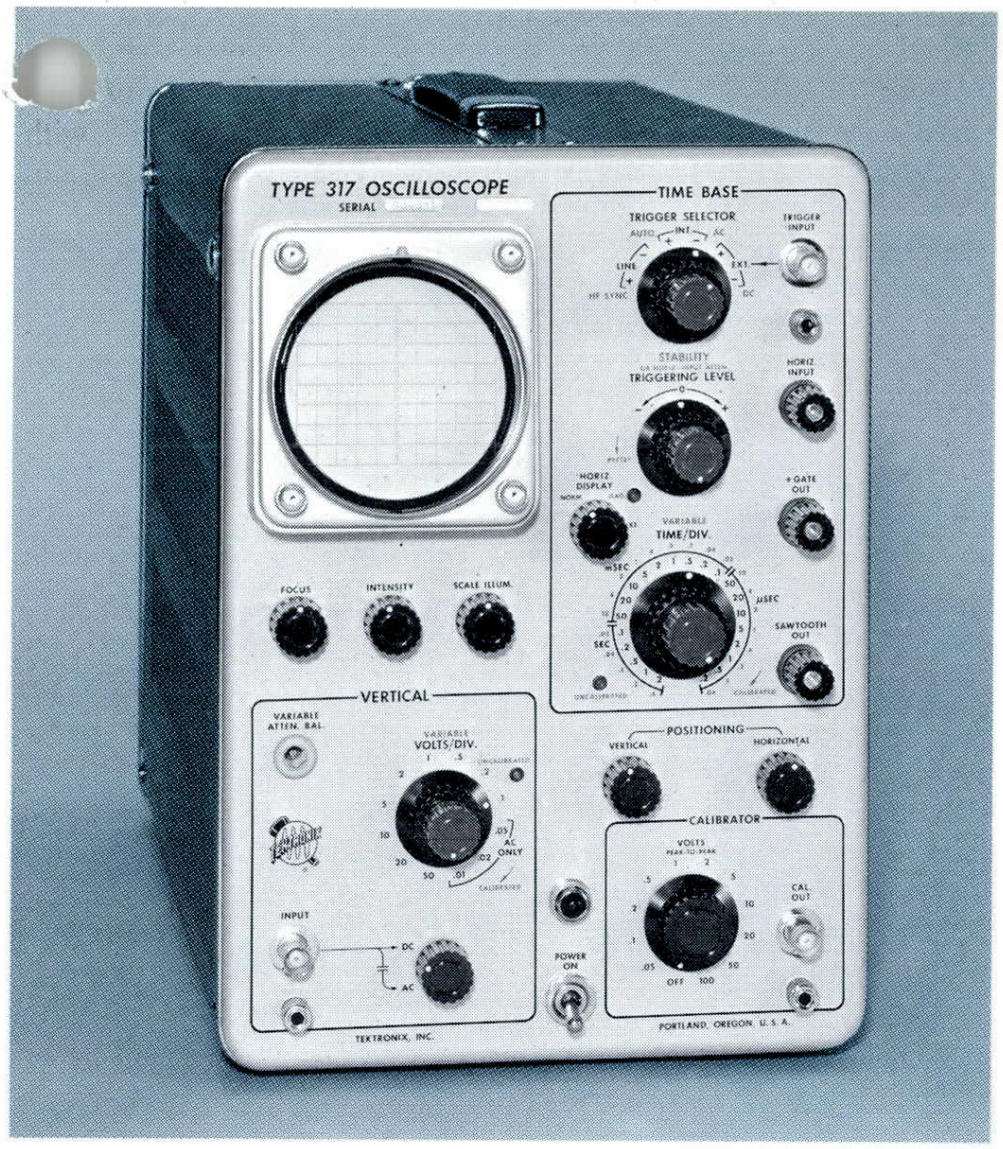


Provides filtered forced-air ventilation recommended for continuous operation at 25°C or higher. Tilts Type 310A for convenient viewing.
Order 016-0012-00 for 105 to 125 V, 50 to 60 Hz $66
Order 016-0013-00 for 210 to 250 V, 50 to 60 Hz $66

*Registered Trademark Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

317 10-MHz Portable Oscilloscopes RM17



- *BRIGHT TRACE*
- *10-MHz BANDWIDTH AT 10 mV/DIV*
- *INTERNAL DELAY LINE*
- *COMPACT CABINET OR RACK MODELS*

The Type 317 is an excellent oscilloscope for the daylight conditions often encountered in the field and at production test stations. Its brilliant trace, provided by 9-kV accelerating potential on a Tektronix 3-inch cathode-ray tube, is easily readable in bright areas . . . even at low sweep-repetition rates. Its DC-to-10 MHz vertical response and wide sweep range provide the measurement capability necessary for many of today's complex field and test station applications. Of course, these fine characteristics make it an excellent laboratory oscilloscope, too.

CHARACTERISTIC SUMMARY

VERTICAL

BANDWIDTH—DC-coupled, DC to 10 MHz. AC-coupled, 2 Hz to 10 MHz.

RISETIME—35 ns.

CALIBRATED DEFLECTION FACTOR—
DC-coupled, 0.1 V/div to 50 V/div.
AC-coupled, 10 mV/div to 50 V/div.

INPUT RC—1 megohm paralleled by approx 40 pF.

HORIZONTAL

CALIBRATED TIME BASE—0.2 μs/div to 2 s/div.

X5 MAGNIFIER—Extends calibrated time base to 40 ns/div.

EXTERNAL INPUT—1.4 V/div, DC to 500 kHz.

CRT

DISPLAY AREA—8 x 10 div. Each div equal to ¼ inch.

ACCELERATING VOLTAGE—9 kV.

PHOSPHOR—P31.

OTHER

AMPLITUDE CALIBRATOR—50 mV to 100 V, approx 1-kHz squarewave.

POWER REQUIREMENTS—105 to 125 V or 210 to 250 V, 300 watts maximum.

10-MHz Portable Oscilloscopes

VERTICAL DEFLECTION

BANDWIDTH
DC to 10 MHz at 3-dB down to 0.1 V/div, 2 Hz to 10 MHz at 3-dB down to 10 mV/div. Low-frequency 3-dB point, AC coupled: 2 Hz, 0.2 Hz with included 10X probe.

RISETIME
≈35 ns.

DEFLECTION FACTOR
10 mV/div to 50 V/div in 12 calibrated steps (1-2-5 sequence), accurate within 3%. AC coupled at 10 mV/div to 50 mV/div. Uncalibrated, continuously variable between steps and to approx 125 V/div. Warning light indicates uncalibrated setting.

INPUT RC
1 megohm paralleled by approx 40 pF.

DELAY LINE
Permits viewing leading edge of displayed waveform.

HORIZONTAL DEFLECTION

TIME BASE
0.2 μs/div to 2 s/div in 22 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to at least 5 s/div. Warning light indicates uncalibrated setting.

X5 MAGNIFIER
Operates over full time base, increases fastest rate to 40 ns/div. Magnified time base accurate within 5%.

EXTERNAL INPUT
1.4 V/div, adjustable. DC to 500 kHz at —3 dB. Input R approx 100 kΩ.

FRONT-PANEL OUTPUTS
≈20-V positive gate, ≈150-V positive-going sawtooth.

TRIGGERING

MODES
Manual or automatic triggering, high-frequency sync. Automatic operation is useful between approx 60 Hz and 2 MHz, minimizes trigger adjustment for signals of different amplitudes, shapes, and repetition rates. With no input, automatic triggering occurs at an approx 50-Hz rate, providing a convenient reference trace. High-frequency sync assures a steady display of sinewaves to 15 MHz.

COUPLING
AC to DC.

SOURCES
Internal, external, or line.

REQUIREMENTS
0.2-div deflection or 0.5 V external from DC to 1 kHz, increasing to 2-div deflection or 4 V external at 5 MHz. AC coupling response —3 dB at approx 16 Hz. Automatic operation requires 0.5-div deflection or 1 V external from 60 Hz to 1 kHz, increasing to 2-div deflection or 4 V external at 2 MHz. High-frequency sync requires 0.2-div deflection or 0.5 V external at 5 MHz, increasing to 2-div deflection or 4 V external at 15 MHz.

CRT

TEKTRONIX CRT
8 x 10-div display area; each div is 1/4 inch. 3-inch tube provides brilliant trace with 9-kV accelerating potential. P31 phosphor is normally supplied; P1, P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. Z-axis input is AC coupled to CRT cathode, requires 10 V peak to peak for beam modulation at normal intensity.

GRATICULE
External; variable edge lighting. Vertical and horizontal centerlines marked in 5 minor divisions per major 1/4-inch division.

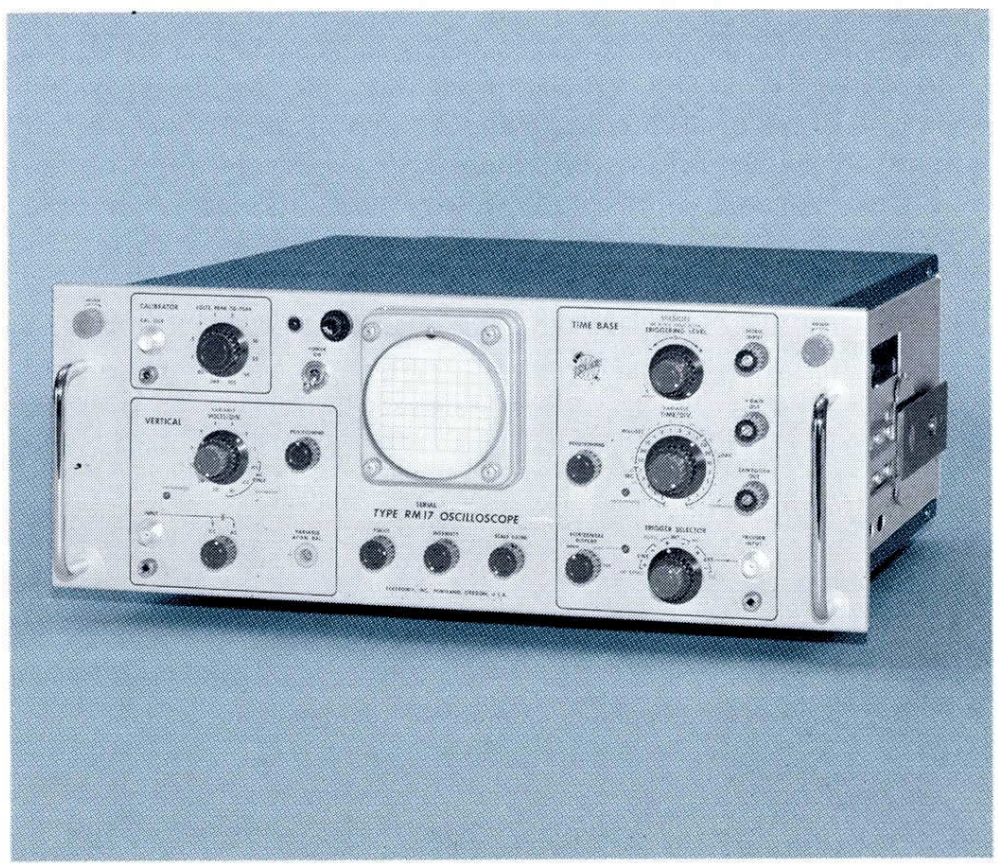
OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR
50 mV to 100-V squarewave, 11 calibrated steps (1-2-5 sequence), accurate within 3%. Approx 1-kHz repetition rate.

POWER REQUIREMENTS
Wired for 105 to 125 VAC (117-V nominal). Transformer taps permit operation at nominal voltages of 110, 117, 124, 220, 234 and 248 VAC, 50 to 60 Hz. Power consumption 300 W maximum. Can be factory wired for any of the above nominal voltages, if so indicated on order.

CABINET MODEL DIMENSIONS AND WEIGHTS

Height	12 3/8 in	31.4 cm
Width	8 1/2 in	21.6 cm
Depth	18 11/16 in	47.5
Net weight	33 lb	15.0 kg
Domestic shipping weight	≈46 lb	≈21.0 kg
Export-packed weight	≈57 lb	≈25.9 kg



RACK MODEL DIMENSIONS AND WEIGHTS

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Rack depth	18 1/8 in	46.0
Net weight	36 1/2 lb	16.6
Domestic shipping weight	≈65 lb	≈29.5 kg
Export-packed weight	≈89 lb	≈40.5 kg

RACKMOUNTING

Type RM17 withdraws from rack on slide-out tracks, tilts and locks in 7 positions. Further mounting information on catalog instrument dimension page.

INCLUDED STANDARD ACCESSORIES

P6012 probe (010-0203-00); 18-inch BNC-to-BNC patch cord (012-0087-00); 18-inch BNC-to-banana plug patch cord (012-0091-00); BNC post jack (012-0092-00); 3-conductor power cord (161-0010-03); 3 to 2-wire adapter (103-0013-00); smoke-gray filter (378-0550-00); two instruction manuals (070-0297-00). Type RM17 includes same accessories except two manuals (070-0325-00); also includes mounting tracks (351-0083-00) and hardware.

TYPE 317 OSCILLOSCOPE **$1050**

TYPE RM17 OSCILLOSCOPE **$1125**

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience. The standard 10X probe supplied with the instrument satisfies most measurement requirements; optional probes may be better suited for particular applications. See catalog accessory pages for additional information on these and other items.

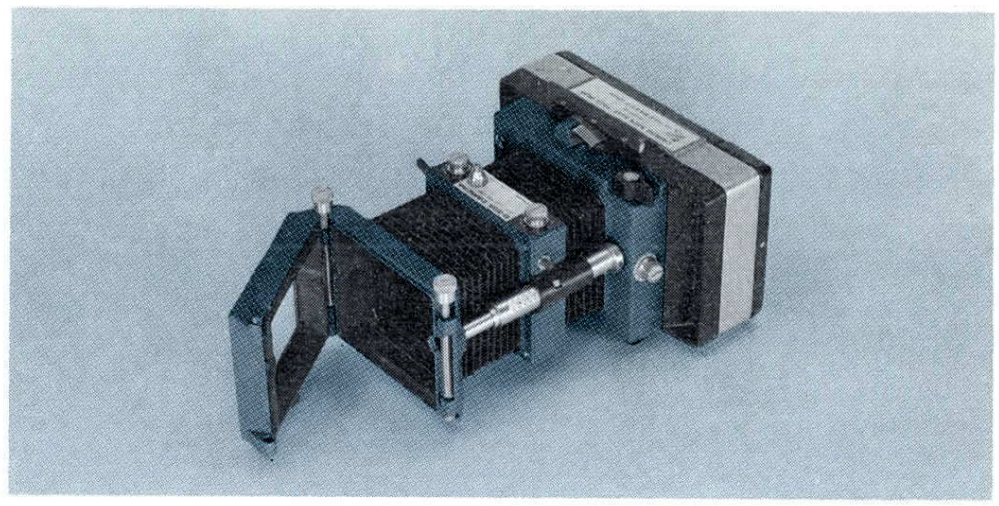
PROBES

P6007 100X Probe Package, order 010-0150-00 . . . . . $29.00

P6011 1X Miniature-Probe Package, order 010-0193-00 $21.00

SUPPORTING CRADLE

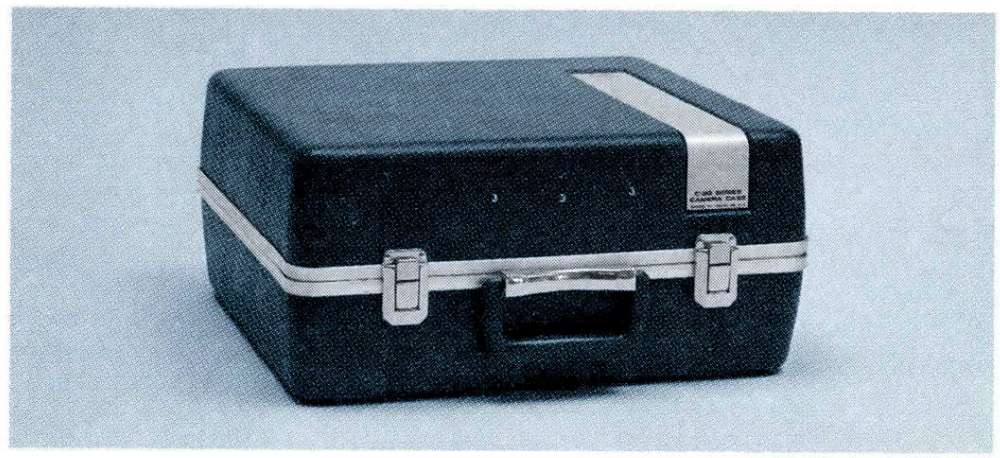
Mod kit required to mount Type RM17 in backless relay rack, order 040-0345-00 . . . . . $ 8.30



C-30A COMPACT CAMERA

f/1.9 lens, magnification variable from 1.5:1 to 0.7:1, Polaroid Land* Pack-Film back for 3000-speed film, order C-30A-P $480

Type 317 to C-30A Camera adapter, order 016-0241-00 $ 16



C-30A CAMERA CARRYING CASE

Constructed of heavy-gage, high-impact plastic, has foam-backed, vacuum-formed styrene liner. Holds C-30A Camera, all standard accessories and extra film.

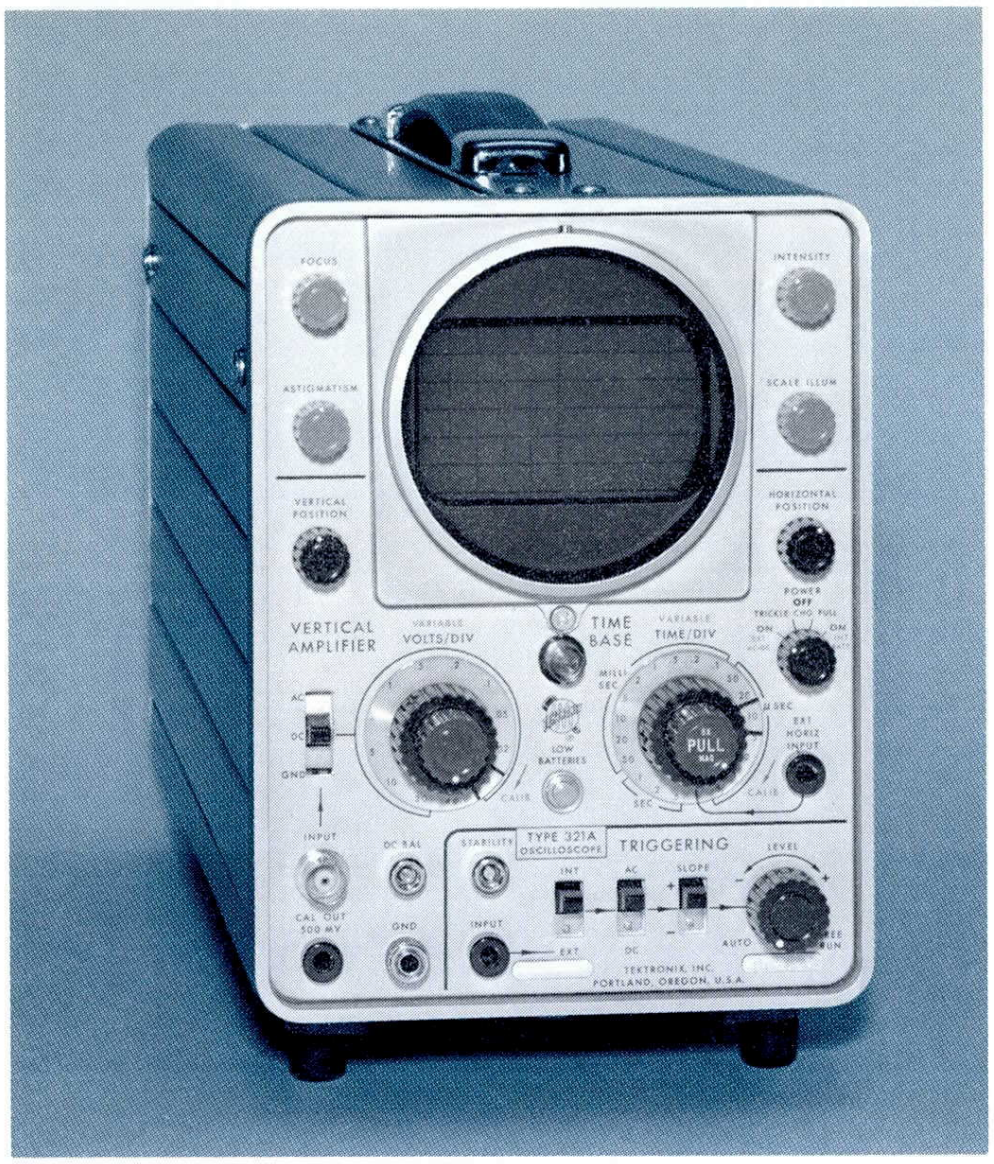
Order 016-0126-00 . . . . . $ 38

*Registered Trademark Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon

Please refer to Terms and Shipment, General Information page.

321A 6-MHz Portable Oscilloscope 321A



- *6-MHz BANDWIDTH AT 10 mV/DIV*
- *SMALL SIZE—LIGHT WEIGHT*
- *ALL SOLID-STATE DESIGN*
- *LOW POWER CONSUMPTION*
- *AC, DC, OR BATTERY OPERATED*
- *UP TO 8-HOURS OPERATION FROM INTERNAL BATTERIES*
- *DESIGNED FOR SEVERE ENVIRONMENTS*

The Type 321A is a high-performance DC-to-6 MHz Oscilloscope. Its rugged mechanical and electrical design plus a choice of power options make it ideal for field operations requiring accurate waveform measurements. FET inputs provide low drift and fast stabilization time. With internal batteries, it weighs 17½ pounds; without batteries, it weighs 14 pounds.

CHARACTERISTIC SUMMARY

VERTICAL

BANDWIDTH—DC to 6 MHz.

RISETIME—58 ns

CALIBRATED DEFLECTION FACTOR—10 mV/div to 20 V/div, DC coupled.

INPUT RC—1 megohm paralleled by approx 35 pF.

HORIZONTAL

CALIBRATED TIME BASE—0.5 μs/div to 0.5 s/div.

X5 MAGNIFIER—Extends time base to 0.1 μs/div.

EXTERNAL INPUT—1 V/div, DC to 1 MHz.

CRT

DISPLAY AREA—6 x 10 div. Each div equal to ¼ inch.

ACCELERATING VOLTAGE—4 kV.

PHOSPHOR—P31

OTHER

AMPLITUDE CALIBRATOR—500-mV squarewave peak to peak and internal 40-mV squarewave peak to peak at approx 2 kHz.

POWER OPTIONS—10 size D batteries; external DC supply of 11.5 to 35 V, ≤700 mA; 115 VAC ±10% or 230 VAC ±10%, 45 to 800 Hz, 20 W.

6-MHz Portable Oscilloscope

321A

VERTICAL DEFLECTION

BANDWIDTH
DC to 6 MHz at 3-dB down. Low-frequency 3-dB-down point with AC coupling is $\leq$2 Hz, extended to $\leq$0.2 Hz when using the included 10X probe.

RISETIME
$\leq$58 ns.

DEFLECTION FACTOR
10 mV/div to 20 V/div in 11 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/div.

INPUT RC
1 megohm within 2%, paralleled by 41 pF within 6 pF.

MAXIMUM INPUT VOLTAGE
500 V (DC + peak AC), <500 V P-P AC.

HORIZONTAL DEFLECTION

TIME BASE
0.5 μs/div to 0.5 s/div in 19 calibrated steps (1-2-5 sequence), accurate within 3% over center 8 divisions. Uncalibrated, continuously variable between steps and to approx 1.5 s/div.

X5 MAGNIFIER
Extends all time base steps, the fastest to 0.1 μs/div. Magnified display accurate within 5% over center 8 divisions.

EXTERNAL INPUT
1 V/div $\pm$10% with X5 magnifier. DC to $\geq$1 MHz at —3 dB. Input RC 100 kΩ within 5% paralleled by 25 pF within 5 pF.

TRIGGER

MODES
Automatic or manual level selection, or free run. Automatic operation is useful above 50 Hz, minimizes trigger adjustment for signals of different amplitudes, shapes, and repetition rates. With no input, automatic triggering occurs at an approx 50-Hz rate, providing a convenient reference trace.

COUPLING
AC or DC.

SOURCES
Internal or external. External trigger input RC 100 kΩ within 20% paralleled by 9 pF within 4 pF.

REQUIREMENTS
0.2-div deflection or 1 V external from DC to 1 kHz, increasing to 1-div deflection or 3 V external at 6 MHz. Requirements increase below 1 kHz for internal AC-coupled triggering, and below approx 30 Hz with external AC-coupled triggering.

CRT

TEKTRONIX CRT
6 x 10-div display area; each div is 1/4 inch. 3-inch tube provides bright trace, utilizes low heater power. 4-kV accelerating potential. P31 phosphor normally supplied; P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. Z-axis input is AC coupled, 5 V P-P at 1 kHz gives visible trace modulation at normal intensity.

GRATICULE
External; variable edge lighting when instrument is operated from AC line. Vertical and horizontal centerlines marked in 5 minor divisions per major 1/4-inch division.

ENVIRONMENTAL CAPABILITIES

AMBIENT TEMPERATURE
Operating (without batteries) —15°C to +55°C.
(with batteries installed) Charge Range, 0°C to +40°C; Discharge Range, —15°C to 40°C.
Non-operating (without batteries) —55°C to +75°C.
(with batteries installed) —40°C to +60°C.

ALTITUDE
Operating: 15,000 ft max.
Non-operating: 50,000 ft max.

VIBRATION
Operating: 15 minutes along each of 3 axes at 0.025 in peak to peak displacement (4 g's at 55 c/s), 10 to 55 to 10 c/s in 1-minute cycles.

SHOCK
Operating: 20 g's, 1/2 sine, 11-ms duration. Two guillotine-type shocks per axis each direction for a total of 12 shocks.
Non-operating: 60 g's, 1/2 sine, 11-ms duration. One guillotine-type shock per axis each direction for a total of 6 shocks.

HUMIDITY
Non-operating: Meets electrical performance specifications after exposure to five cycles (120 hours) of Mil-Std-202C, Method 106B (omit freezing and vibration, and allow a post-test drying period at +20°C and 25% to 80% relative humidity).

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR
500 mV at external jack; accurate within 3% throughout operating range. 40 mV applied internally to vertical amplifier; accurate within 2% throughout operating range. $\leq$1-μs risetime; 2 kHz $\pm$20% repetition rate; 45% to 55% duty cycle.

POWER OPTIONS
Wired for 115 V RMS $\pm$10%, 45 to 800 Hz; tapped transformer also allows operation at 230 V $\pm$10%; 20-W maximum power consumption for oscilloscope only, 30-W maximum with internal batteries under full charge. Operates on external DC supply from 11.5 to 35 V DC; draws $\leq$600 mA. Operates on 10 internal size D batteries. NiCd rechargeable cells provide approx 8 hours continuous operation. Front-panel light indicates when internal batteries are low, or (using external power) when the voltage source drops too low for proper power supply regulation. Recharge requires at least 16 hours.

BATTERY CHARGER
Internal charger provides two different charging currents to the internal batteries. A trickle charge or a full charge is applied to the internal batteries when the instrument is turned off, but connected to the AC line.

6-MHz Portable Oscilloscope

321A

DIMENSIONS AND WEIGHTS

Height	8¾ in	22.2 cm
Width	5¾ in	14.6 cm
Depth	16½ in	41.9 cm
Net weight	14¼ lb	6.5 kg
Domestic shipping weight	≈22 lb	≈10.0 kg
Export packed weight	≈33 lb	≈15.0 kg

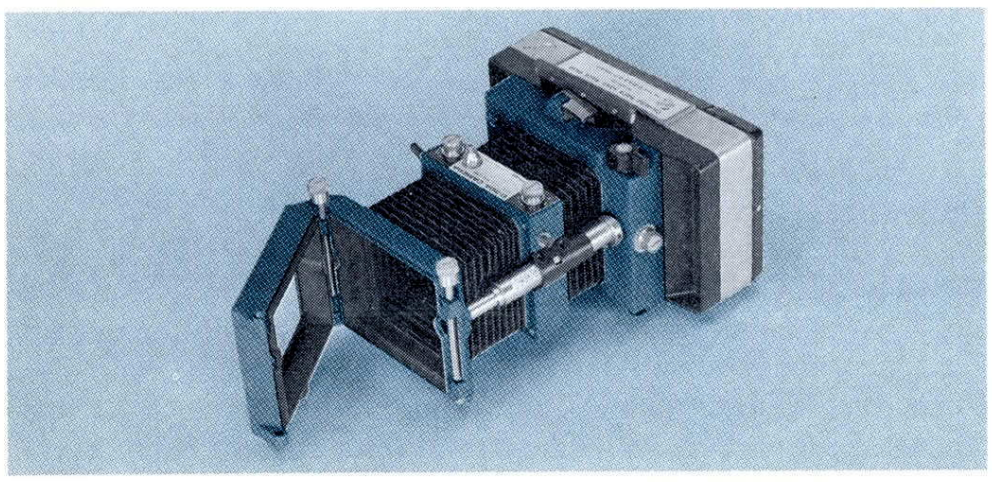
INCLUDED STANDARD ACCESSORIES

P6012 10X probe (010-0203-00); two 18-inch BNC-to-banana plug patch cords (012-0091-00); DC power cord (161-0016-01); AC power cord (161-0015-01); 3 to 2-wire adapter (103-0013-00); smoke-gray light filter (378-0547-00); mesh filter, installed (378-0577-00); two instruction manuals (070-0891-00).

TYPE 321A OSCILLOSCOPE, without batteries **$1045**

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience. The standard 10X probe supplied with the instrument satisfies most measurement requirements; optional probes may be better suited for particular applications. In addition to the listed optional probes, other probes are available for current and high-voltage measurements. See catalog accessory pages for additional information on these and other items.

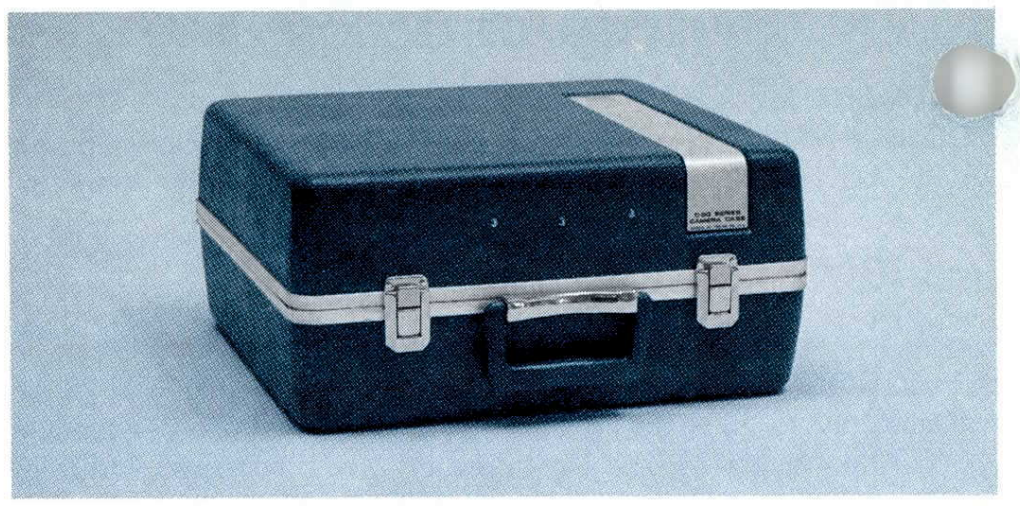


C-30A COMPACT CAMERA

f/1.9 lens, magnification variable from 1.5:1 to 0.7:1, Polaroid Land* Pack-Film back for 3000-speed film, order C-30A-P $480

321A to C-30A Camera adapter, order 016-0242-00 . . . . $ 16

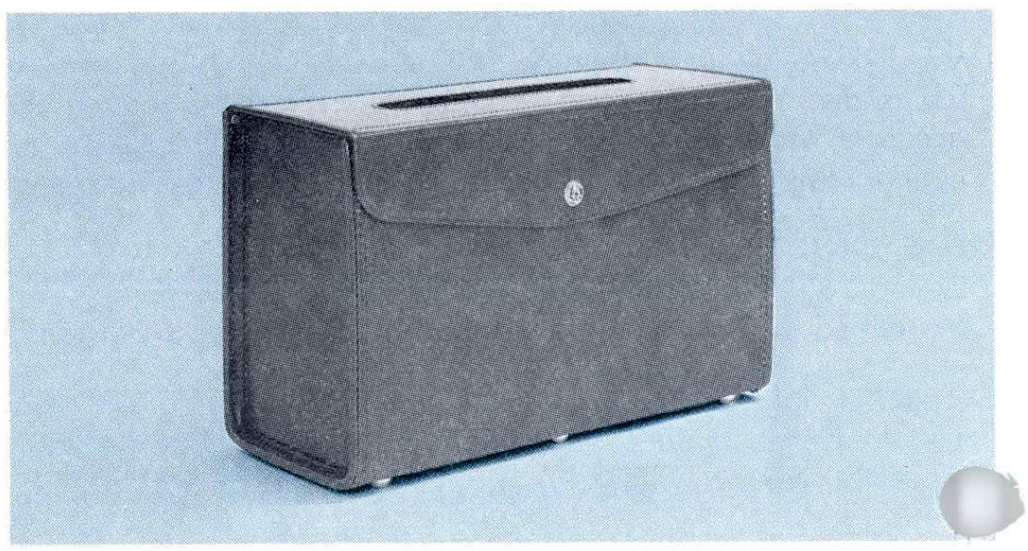
*Registered Trademark Polaroid Corporation



C-30A CAMERA CARRYING CASE

Constructed of heavy-gage, high-impact plastic, has foam-backed, vacuum-formed styrene liner. Holds C-30A Camera, all standard accessories and extra film.

Order 016-0126-00 . . . . . $38



CARRYING CASE

Protects Type 321A, provides convenient accessory storage compartment, order 016-0026-00 . . . . . $44

RECHARGEABLE BATTERIES

Each NiCd cell, order 146-0010-00 . . . . . $ 8

Set of 10 NiCd cells, order 016-0077-01 . . . . . $77

PROBES

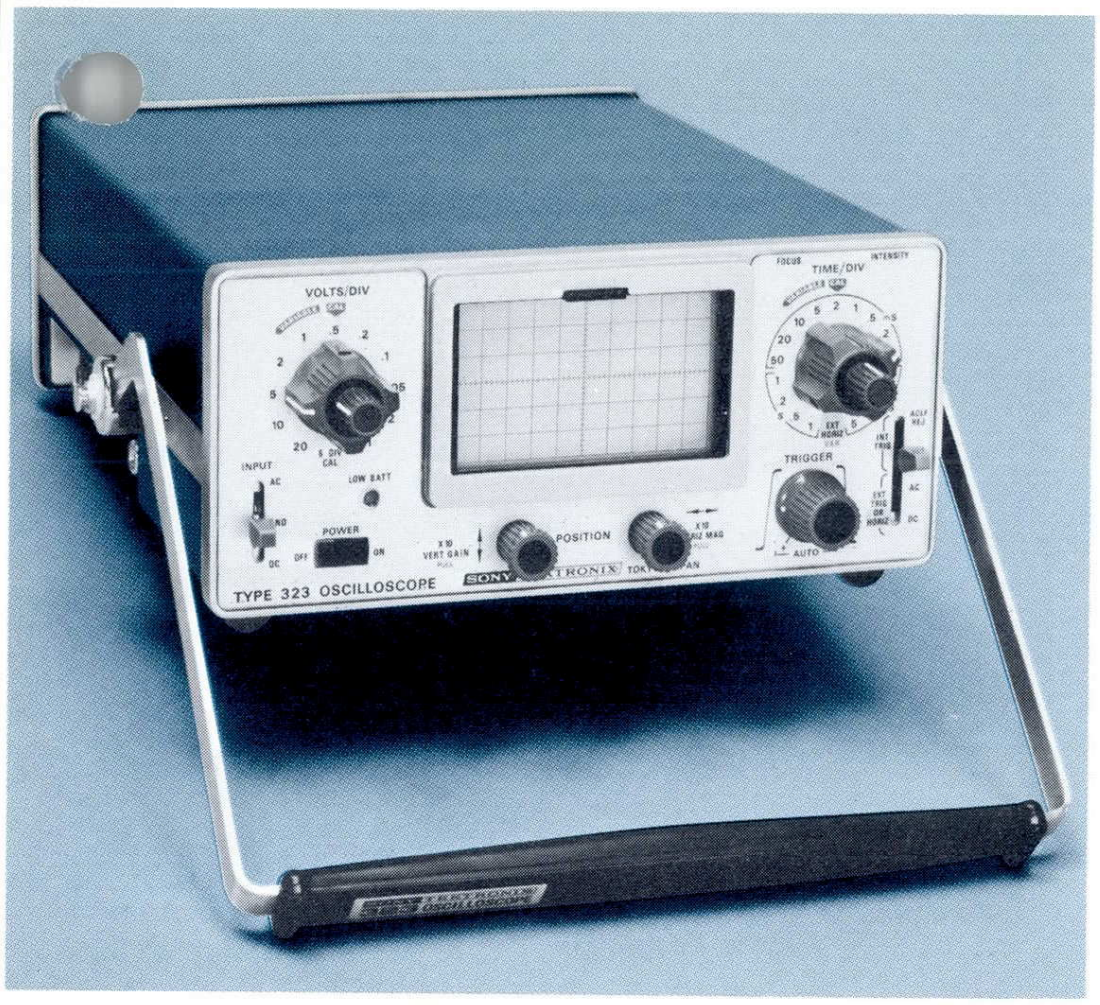
P6007 100X Probe Package, order 010-0150-00 . . . . . $29

P6011 1X Miniature-Probe Package, order 010-0193-00 . . $21

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

4-MHz Portable Oscilloscope

323



- AC, DC OR BATTERY POWERED
- COMPACT SIZE—WEIGHT ≈7 lb
- ALL SOLID-STATE RELIABILITY
- 4-MHz BANDWIDTH AT 10 mV/DIV
- UP to 7-HOURS OPERATION FROM INTERNAL BATTERY PACK
- DESIGNED FOR SEVERE ENVIRONMENTS
- CONVENIENT ACCESSORY STORAGE

The Type 323 is an all solid-state, single-channel, 4-MHz portable oscilloscope providing the operator the convenience of using AC, DC or internal rechargeable batteries for powering the instrument. The 323 features small size and light weight, together with extremely low power consumption. Depth is $10\frac{5}{8}$ inches, width—$8\frac{1}{2}$ inches, height—$4\frac{1}{4}$ inches, weight—≈7 pounds. Power consumption is up to 4.5 watts, typically 1.6 watts from an external DC source and 14 watts when powered from the AC line. Internal rechargeable batteries will provide up to 7 hours continuous operation, sufficient for a full working day. The portability/performance provided by the Type 323 Oscilloscope, makes it most attractive for use in "on-site" maintenance applications; for example, industrial control equipment, communication systems, business machines and computers.

CHARACTERISTIC SUMMARY

VERTICAL

BANDWIDTH—DC to 4 MHz.

RISETIME—90 ns.

CALIBRATED DEFLECTION FACTOR—10 mV/div to 20 V/div at full bandwidth, 1 mV/div at 2.75-MHz bandwidth.

INPUT RC—1 megohm paralleled by approx 47 pF.

HORIZONTAL

CALIBRATED TIME BASE—5 μs/div to 1 s/div.

X10 MAGNIFIER—Extends time base to 0.5 μs/div.

EXTERNAL INPUT—20 mV/div to 30 V/div, continuously variable, DC to 10 kHz.

CRT

DISPLAY AREA—6 x 10 divisions ($\frac{1}{4}$ inch/division).

PHOSPHOR—P31.

OTHER

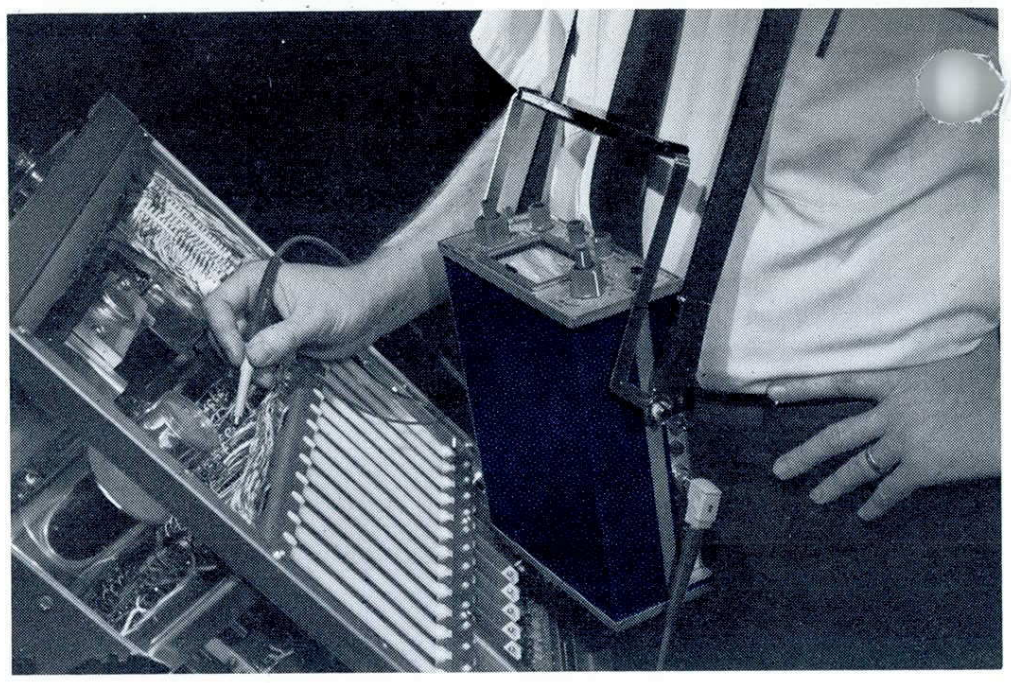
AMPLITUDE CALIBRATOR—Internal, 0.5 V at external jack.

POWER SOURCES—Internal batteries; external DC supply of 6 to 16 V, 4.5 W; 90 to 136 VAC or 180 to 272 VAC, 48 Hz to 440 Hz, 14 W at 115 VAC.

4-MHz Portable Oscilloscope

323

EASY TO CARRY
Adjustable handle and included shoulder strap make this 7-pound oscilloscope easy to carry.



EASY TO USE
Small size of the Type 323 makes it easy to carry around the neck or support in the lap.

VERTICAL DEFLECTION

BANDWIDTH
DC to at least 4 MHz at 3-dB down. DC to at least 2.75 MHz at 3-dB down using X10 gain. Low-frequency 3-dB-down point with AC coupling is 2 Hz or less, extending to 0.2 Hz or less with the included 10X probe.

RISETIME
90 ns or less; 130 ns or less using X10 gain.

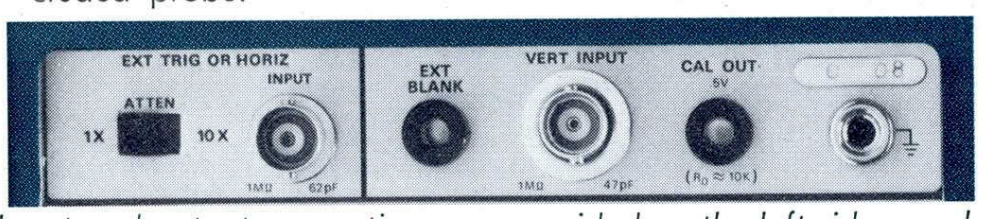
DEFLECTION FACTOR
10 mV/div to 20 V/div in 11 calibrated steps (1-2-5 sequence), 1 mV/div to 2 V/div using X10 gain, all steps accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/div.

ABERRATIONS
At the 10 mV/div vertical attenuator setting, aberrations are +2%, −2% or less, total of 3% P-P or less at −15°C to +55°C. At all other V/div settings, aberrations are +3%, −3% or less, total of 3% P-P or less at 0°C to +55°C and +4%, −4% or less, total of 4% P-P or less at −15°C to +55°C.

INPUT RC
1 megohm within 2% paralleled by 47 pF within 4 pF.

MAXIMUM INPUT VOLTAGE
500 V (DC + peak AC).

DISPLAYED NOISE
0.1 div or less at 1 mV/div, using 50-Ω termination or included probe.



Input and output connections are provided on the left side panel, freeing important front panel space for operating controls.

HORIZONTAL DEFLECTION

TIME BASE
5 μs/div to 1 s/div in 17 calibrated steps (1-2-5 sequence), accurate within 3%, over the center 8 divisions, from 5 μs/div to 0.2 s/div, accurate within 4% from 0.5 s/div to 1 s/div. Uncalibrated, continuously variable between steps and to approx 2.5 s/div.

X10 MAGNIFIER
Operates over full time base, increases fastest sweep rate to 0.5 μs/div. Accuracy of magnified display is within 4%, over the center 8 divisions, from 2 μs/div to 20 ms/div, within 5% at 0.5 μs/div, 1 μs/div, 50 ms/div, and 0.1 s/div.

EXTERNAL INPUT
Continuously variable from approx 20 mV/div to approx 30 V/div, AC or DC coupled. DC to at least 10 kHz at 3-dB down.

TRIGGER

MODES
Automatic or manual level and slope selection with a single control. Automatic operation minimizes trigger adjustments and is useful above 30 Hz. With no input, automatic triggering provides a bright baseline at all sweep rates.

COUPLING
AC and AC LF REJ for internal triggering, AC and DC for external triggering. 300-V maximum input voltage (combined DC + peak AC).

AMPLITUDE REQUIREMENTS
0.3-div deflection or 75 mV external to 400 kHz, increasing to 0.75-div deflection or 190 mV external at 4 MHz. Requirements increase below 30 Hz with internal or external AC coupling and below 30 kHz with AC LF REJ coupling.

CRT

CRT
6 x 10-div display area; each div is 1/4 inch. CRT uses direct heated cathode, providing a useful display approx two seconds after turn-on. P31 phosphor normally supplied; P7 is optional without extra charge. Consult your Field Engineer, Representative or Distributor for application information and availability. External blanking input requires +5 V to +20 V (DC coupled), is usable from DC to at least 100 kHz. 150-V maximum input voltage (combined DC + peak AC).

GRATICULE
Internal, black, non-illuminated. Vertical and horizontal centerlines marked in 5 minor divisions per major 1/4-inch division.

ENVIRONMENTAL CAPABILITIES

AMBIENT TEMPERATURE
Operating: −15°C to +55°C.
Non-operating: −55°C to +75°C (without batteries).
−40°C to +60°C (with batteries).
Charging: −0°C to +40°C.

ALTITUDE
Operating: 30,000 feet; maximum ambient temperature rating must be decreased by 1°C/1000 feet from 15,000 feet to 30,000 feet.
Non-operating: 50,000 feet.

VIBRATION

Operating: 15 minutes along each of the 3 major axes, 0.025 inch peak-to-peak displacement (4 g's at 55 c/s) 10 to 55 to 10 c/s in 1-minute cycles.

SHOCK

Operating and non-operating: 30 g's, ½ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

ELECTROMAGNETIC INTERFERENCE

Meets radiated interference requirements of MIL-I-6181D and MIL-I-1690C over the range 150 kHz to 1 GHz. Instrument must be battery operated with CRT mesh filter (378-0596-00) installed. Installation of the CRT mesh filter diminishes the usefulness of the internal non-illuminated graticule.

HUMIDITY

Non-operating: Meets electrical performance specifications after exposure to five cycles (120 hours) of Mil-Std-202C. Method 106B (omit freezing and vibration, and allow a post-test drying period at +25°C ±5°C at 20% to 80% relative humidity).

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR

0.5 V at external jack, accurate within 1% from +20°C to +30°C, within 2% throughout the operating temperature range. Output resistance approx 10 kΩ. Risetime 2 μs or less; duty cycle 40% to 60%. Output also switchable internally to vertical amplifier.

PROBE

The P6049 is a miniaturized 10X probe with 3.5-foot cable, and right-angle swivel BNC connector. Input RC with probe is 10 MΩ within 2% paralleled by less than 13.5 pF.

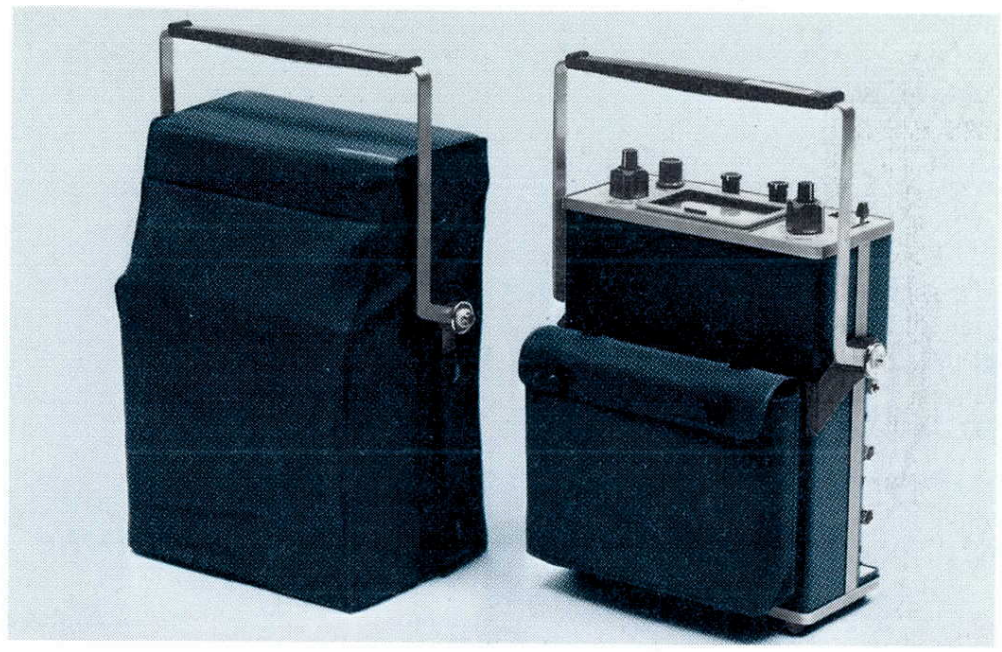
POWER SOURCES

Battery operation: removable power pack contains 6 size "C" NiCd cells providing 3 to 7 hours operation. Operating time depends on signal frequency and amplitude, the setting of trace intensity, operating temperature and temperature during previous battery charge. Maximum time is achieved at 20°C to 25°C charge and 20°C to 30°C operating temperature. Internal charger provides for charging the internal batteries when connected to the AC line, operating or non-operating. Recharge requires at least 16 hours at full charge. A Trickle Charge position prevents battery self-discharge when not in use.

External DC source: operates from an external DC source of 6 V to 16 V, requires up to 4.5 W, typically 1.6 W.
External AC source: operates from an external AC source of 90 to 136 V, or 180 to 272 V. 48 to 440 Hz, 14 W maximum at 115 VAC.

DIMENSIONS AND WEIGHTS

Height	4¼ in	10.8 cm
Width without handle	7¼ in	18.4 cm
Width with handle	8½ in	21.6 cm
Depth with panel cover	10⅝ in	27.0 cm
Depth with handle extended	12¾ in	32.3 cm
Net weight without accessories	≈7 lb	≈3.2 kg
Domestic shipping weight	≈13 lb	≈5.9 kg
Export-packed weight	≈21 lb	≈9.5 kg



Optional rain jacket (left) slips over the Type 323 and its included accessory pouch (right).

INCLUDED STANDARD ACCESSORIES

P6049 10X probe (010-0223-00); patch cord (012-0089-00); accessory pouch (016-0113-00); viewing hood (016-0247-01); 3 to 2-wire adapter (103-0013-00); BNC-to-binding post adapter (103-0033-00); power cord (161-0043-00); panel cover (200-0812-00); strap assembly (346-0051-00); smoke-gray light filter (426-0403-00); two instruction manuals (070-0750-00).

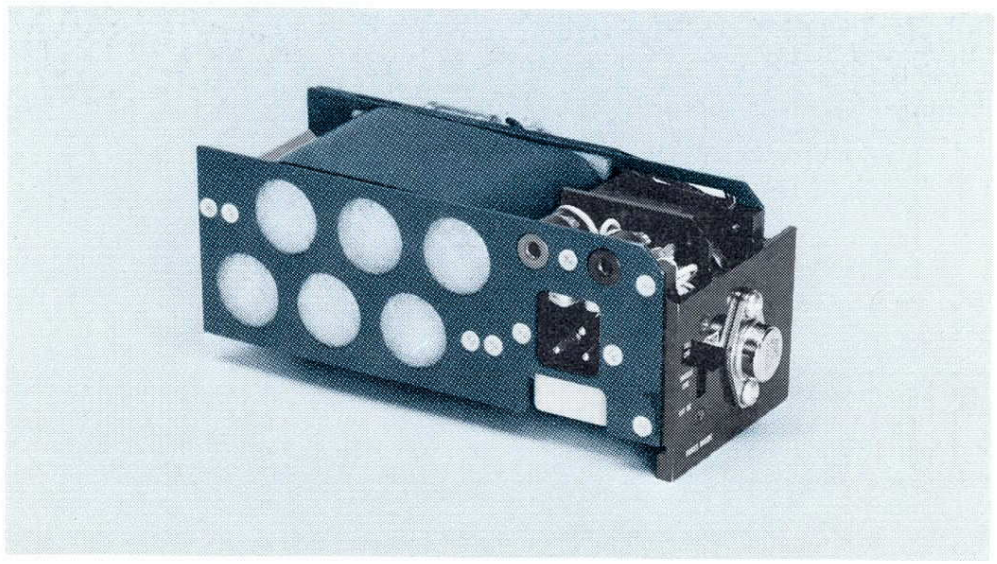
TYPE 323 OSCILLOSCOPE, including batteries $960

The SONY®/TEKTRONIX® Type 323 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the Type 323 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

OPTIONAL ACCESSORIES

RAIN JACKET

The rain jacket provides protection for the Type 323 during transport or storage, is constructed of waterproof blue vinyl, order 016-0112-00 . . . . . $ 8



POWER PACK

Extra power pack, in addition to the one supplied with the Type 323 allows one power pack to charge while the other is powering the oscilloscope. Pack contains 6 size "C" NiCd cells and battery charger, order 016-0119-02 . . . . . $98

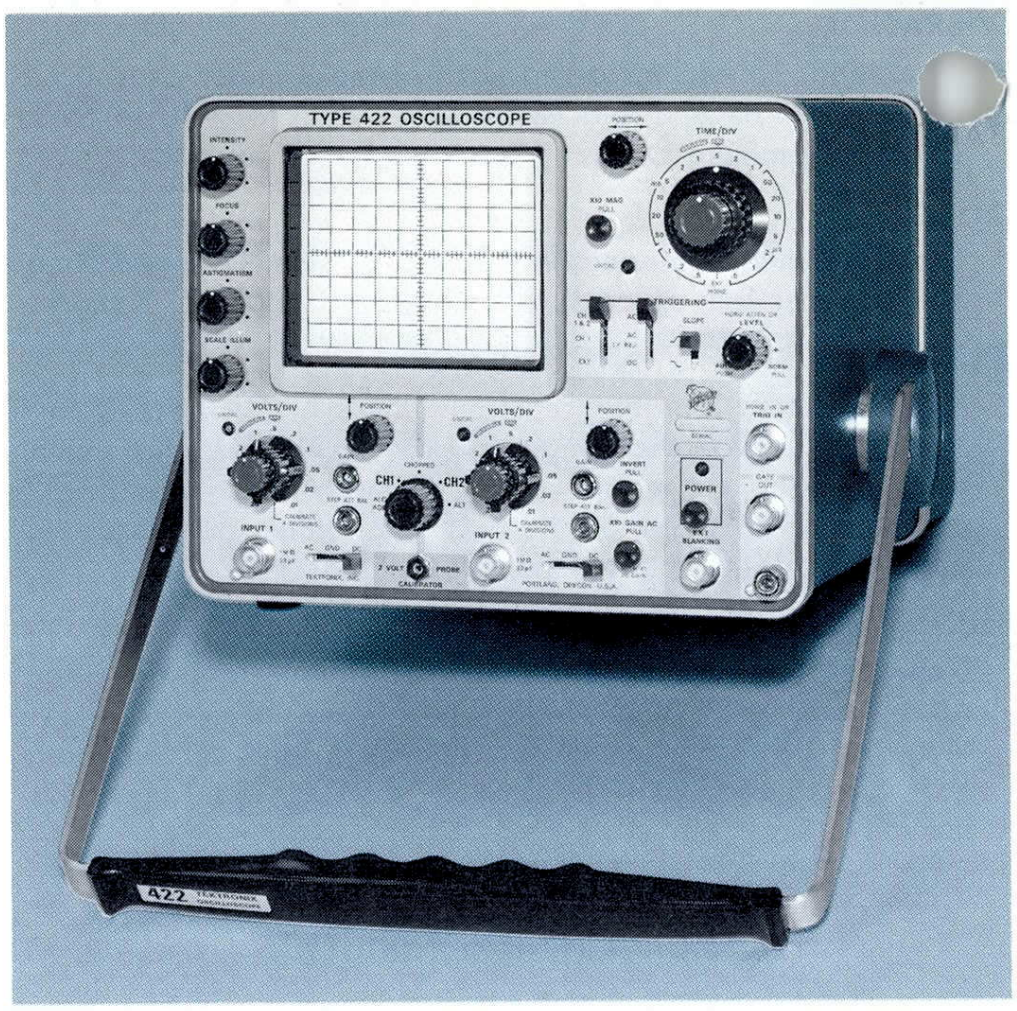
BATTERY SET

Set of 6 NiCd cells, order 146-0012-01 . . . . . $23

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

422 15-MHz Dual-Trace Portable Oscilloscopes R422

- *COMPACT SIZE—LIGHT WEIGHT*
- *DUAL TRACE, FET INPUTS*
- *DESIGNED FOR SEVERE ENVIRONMENTS*
- *AC AND AC/DC VERSIONS*
- *UP TO 5 HOURS OPERATION FROM INTERNAL BATTERY PACK (AC/DC VERSION)*
- *ILLUMINATED PARALLAX-FREE GRATICULE*



The Type 422 is a portable dual-trace oscilloscope that combines small size and light weight with the ability to make precise waveform measurements. It weighs under 22 pounds and is ruggedly constructed to withstand shock, vibration, and other extremes of environment. Solid-state design, using FET input circuitry, provides minimum drift and fast stabilization time. No longer need measurements be compromised due to adverse field conditions; the Type 422 brings the precision of the laboratory to the field.

Two models are available. One operates on AC; the other on AC or DC, with an optional battery pack providing up to 5 hours operating time for completely portable operation. The AC model is also available as Type R422, arranged in a rack-mount panel assembly with a hinged-door compartment for storing accessories. The hinged door can be removed to allow the installation of a second Type 422 for applications that require two instruments. The entire assembly is mounted to the rack with slide-out tracks.

CHARACTERISTIC SUMMARY

VERTICAL

(2 Identical Channels)

BANDWIDTH—DC to 15 MHz.

RISETIME—24 ns.

CALIBRATED DEFLECTION FACTOR—10 mV/div to 20 V/div.

INPUT RC—1 megohm paralleled by 33 pF.

HORIZONTAL

CALIBRATED TIME BASE—0.5 μs/div to 0.5 s/div.

X10 MAGNIFIER—Extends fastest time-base to 0.05 μs/div.

EXTERNAL INPUT—1 V/div to 100 V/div, DC to 500 kHz.

CRT

DISPLAY AREA—8 x 10 divisions (0.8 cm/div).

ACCELERATING VOLTAGE—6 kV.

PHOSPHOR—P31.

OTHER

AMPLITUDE CALIBRATOR—0.2 V peak to peak, internally; 2 V peak to peak, front-panel jack; 1-kHz squarewave (approx).

POWER OPTIONS—
AC Model: 90 to 140 VAC or 180 to 280 VAC, 45 to 440 Hz, approx 100 W. AC/DC Model: AC mode—92 to 137 VAC or 184 to 274 VAC, 45 to 440 Hz, maximum 30 W. DC mode—11.5 to 35 VDC, maximum 26 W. Also accepts 24-V battery pack.

VERTICAL DEFLECTION
(2 Identical Channels)

BANDWIDTH
DC to 15 MHz at 3-dB down (each channel); 5 Hz to 5 MHz at 3-dB down, on X10 gain (channel 2). Low-frequency 3-dB-down point is <2 Hz with AC coupling (each channel), <0.2 Hz with included 10X probe.

RISETIME
24 ns each channel; 70 ns at X10 gain (channel 2).

DEFLECTION FACTOR
10 mV/div to 20 V/div in 11 calibrated steps, 1-2-5 sequence (each channel). Deflection factor extended to 1 mV/div in X10 position (channel 2). All steps accurate within 3%; 7.5% on X10 GAIN (channel 2). Uncalibrated, continuously variable between steps and to approx 50 V/div. Warning light indicates uncalibrated setting.

DC DRIFT
Drift with time—
Short term: (ambient temperature and line voltage constant) 0.1 div or less during any minute within first hour after 20-minute warm-up.
Long term: (with ambient temperature 20°C to 30°C and line voltage constant) 0.2 div or less during first hour after 20-minute warm-up.
Drift with temperature—0.2 div or less per 10°C.

INPUT RC
1 megohm ±2% paralleled by 33 pF ±1 pF.

MAXIMUM INPUT VOLTAGE
[illegible]0 V (DC plus peak AC), AC not to exceed 300 V P-P at 1 kHz or less.

OPERATING MODES
Channel 1 only; Channel 2 only; Channels 1 and 2 added algebraically; dual-trace chopped; dual-trace alternate. In chopped operation, successive 2 to 4.7-μs segments of each channel are displayed at an approx 150-kHz rate. Channel 2 has polarity inversion. Common-mode rejection ratio is ≥100:1 at 50 kHz with Channels 1 and 2 adjusted for equal gain.

DELAY LINE
Permits viewing of leading edge of triggering waveform.

HORIZONTAL DEFLECTION

TIME BASE
0.5 μs/div to 0.5 s/div in 19 calibrated steps (1-2-5 sequence), accurate within 3% over center 8 div. Uncalibrated, continuously variable between steps and to approx 1.25 s/div. Warning light indicates uncalibrated vernier settings.

X10 MAGNIFIER
Operates over full time base, increases fastest rate to 50 ns/div. Accuracy of magnified time base is within 5% over center 8 div.

EXTERNAL INPUT
Variable between approx 1 V/div to 100 V/div. DC to ≥500 kHz at 3-dB down. Input RC 300 kΩ ±10% paralleled by 35 pF ±3 pF.

[illegible]ER
[illegible]e output (on front panel) is a negative-going rectangular pulse with same duration as time base; 0.5-V minimum; 620-ohm ±10% source impedance.

TRIGGER

MODES
Automatic or Normal. Automatic operation useful between 20 Hz and 15 MHz, minimizes trigger adjustments for signals of different amplitudes, shapes and repetition rates. With no input (or input less than 20 Hz), the automatic triggering free runs the sweep and provides a bright reference trace at all sweep rates.

COUPLING
DC; AC; AC LOW FREQ REJECT.

SOURCES
Internal: Channels 1 and 2, Channel 1 only;
External: Input RC is 100 kΩ ±3% paralleled by 33 pF ±5 pF. Positive or Negative slope. Trigger level range at least +10 V to −10 V. Maximum input voltage 250 V (DC plus peak AC).

REQUIREMENTS
DC: 0.2-div deflection or 125 mV ext up to 5 MHz, increasing to 1 div or 0.6 V at 15 MHz.
AC: Same as DC above 50 Hz.
AC LOW FREQ REJECT: Same as DC above 50 kHz.

ENVIRONMENTAL FEATURES

AC MODEL

Ambient Temp:	Operating: −15°C to +55°C. Non-operating: −55°C to +75°C.
Altitude:	Operating: 15,000 ft, maximum. Non-operating: 50,000 ft, maximum.
Humidity:	Operating and storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F.
Vibration:	Operating: 15 minutes along each of 3 axes at 0.025 inch peak to peak displacement (3.9 g's at 55 c/s), 10-55-10 c/s in 1-minute cycles.
Shock:	Non-operating: 30 g's, ½ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.
EMI:	Meets interference requirements of MIL-I-6181D, Power line conducted: 150 kHz—25 MHz. Radiated (with mesh filter installed): 150 kHz—1000 MHz.

AC/DC MODEL, with batteries
Same as AC MODEL, with these exceptions:

Temperature:	Operating: −15°C to +40°C Non-operating: −40° C to +60° C
Humidity:	Derate temperature to +60°C.

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR
Squarewave, 1 kHz within 20%, negative-going. Provides 0.2 V, internally, ±1.5% (+20°C to +30°C), and 2 V, ±0.5% (+20°C to +30°C), at Probe Cal jack on front panel.

422 15-MHz Dual-Trace Portable Oscilloscopes R422

POWER OPTIONS

AC Model: 90 to 140 VAC or 180 to 280 VAC, 45 to 440 Hz, 100 watts at 115 VAC.

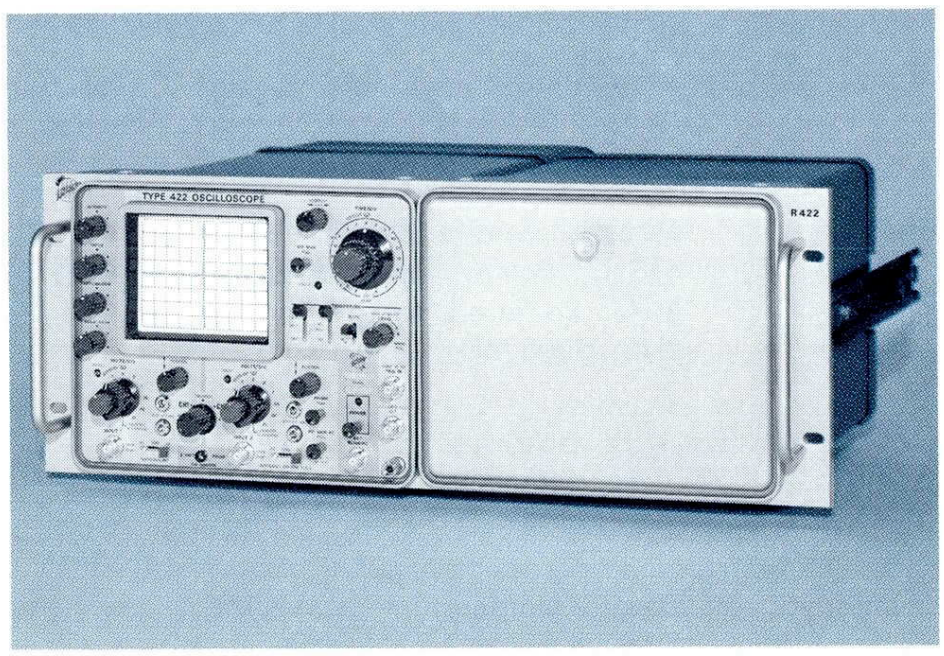
AC/DC Model: AC mode: 92 to 137 VAC or 184 to 274 VAC, 45 to 440 Hz, 30 W maximum. DC mode: 11.5 to 35 VDC, 26 W maximum (constant power: 2.3 A max, 750 mA min). 24-V battery pack (part number 016-0066-02) provides up to 5-hours continuous operation.

TEKTRONIX CRT

Rectangular, 4-inch, with 0.8-cm divisions; 8 x 10-div display area. Illuminated internal graticule. 6-kV accelerating potential. External blanking, DC-coupled +2 V and greater will completely blank trace. P31 phosphor normally supplied; P1, P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability.

DIMENSIONS AND WEIGHTS (Type 422)

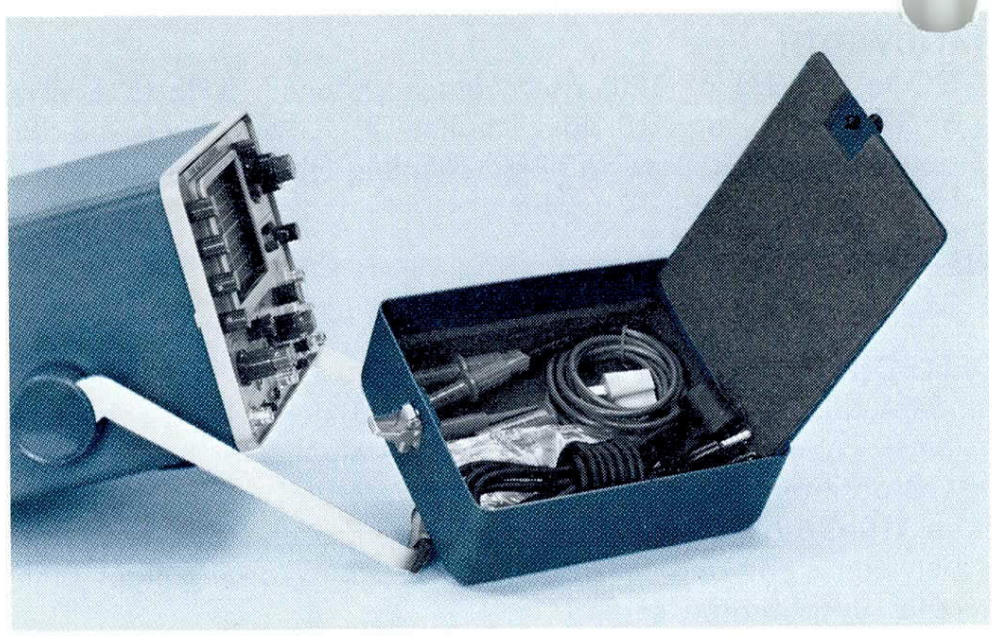
Height	$6\frac{15}{16}$ in	17.7 cm
Width	$9\frac{3}{8}$ in	23.8 cm
Depth (including panel cover)		
AC Model	$15\frac{3}{4}$ in	40.0 cm
AC/DC Model	$18\frac{9}{16}$ in	47.2 cm
Depth (with extended handle)		
AC Model	$17\frac{13}{16}$ in	45.4 cm
AC/DC Model	$20\frac{5}{8}$ in	52.4 cm
Weight (with front cover and accessories)		
AC Model	$21\frac{1}{4}$ lb	9.7 kg
AC/DC Model without batteries	23 lb	10.5 kg
AC/DC Model with batteries	30 lb	13.7 kg
Domestic shipping weight		
AC Model	≈30 lb	≈13.6 kg
AC/DC Model without batteries	≈32 lb	≈14.6 kg
Export-packed weight		
AC Model	≈44 lb	≈20.0 kg
AC/DC Model without batteries	≈46 lb	≈20.9 kg



DIMENSIONS AND WEIGHTS (Type R422)

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Depth behind front panel	$12\frac{1}{2}$ in	31.8 cm
Net weight	$23\frac{1}{4}$ lb	10.6 kg
Domestic shipping weight	≈50 lb	≈22.7 kg
Export-packed weight	≈73 lb	≈33.2 kg

TYPE 422 AC POWERED PORTABLE



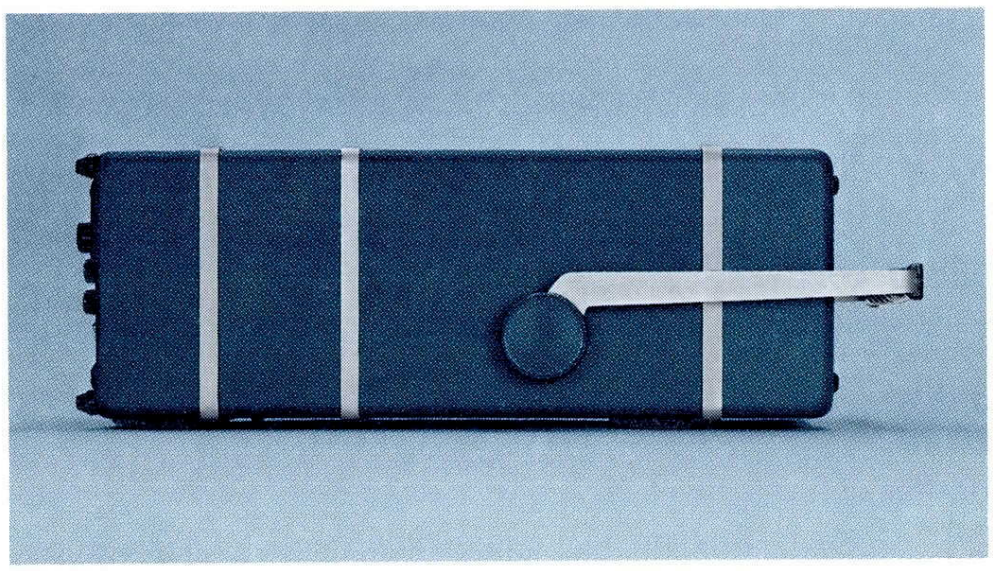
Panel cover provides storage for standard accessories.

INCLUDED STANDARD ACCESSORIES

Two P6012 10X probe (010-0203-00); adapter, BNC to binding post (103-0033-00); ornamental ring (354-0248-00); light graticule, smoke-gray filter (378-0549-00); clear, CRT protector plate (386-0118-00); mesh filter, installed, (378-0571-00); AC power supply (016-0072-00); 3 to 2-wire adapter (103-0013-00); power cord, 117 V, 3-conductor, right-angle, female with straight male plug (161-0024-03); two instruction manuals (070-0894-00).

TYPE 422 OSCILLOSCOPE **$1500**

TYPE 422 AC/DC POWERED PORTABLE
MOD 125B



422 MOD 125B *(Shown with protective cover in place)*

INCLUDED STANDARD ACCESSORIES

Type 422 with AC/DC battery power supply, less batteries. Two P6012 10X probe (010-0203-00); ornamental ring (354-0248-00); light graticule, smoke-gray filter (378-0549-00); clear, CRT, protector plate (386-0118-00); mesh filter, installed (378-0571-00); AC/DC power supply (016-0073-00); 3 to 2-wire adapter (103-0013-00); 3-wire AC with female connector and male plug power cord (161-0015-01); 3-wire DC with female connector power cord (161-0016-01); BNC to binding post adapter (103-0033-00); two instruction manuals (070-0895-00).

TYPE 422 MOD 125B OSCILLOSCOPE, without Battery **$1650**

BATTERY PACK FOR TYPE 422 MOD 125B

Order 016-0066-02 ..... $140

TYPE R422 AC POWERED RACKMOUNTS

OSCILLOSCOPE ON LEFT

Type R422 Oscilloscope (mounted on left side) includes accessories listed for Type 422 above plus slide-out tracks (351-0100-00); and mounting hardware.

TYPE R422 OSCILLOSCOPE **$1575**

OSCILLOSCOPE ON RIGHT, MOD 150E

Type R422 Oscilloscope (mounted on right side) includes accessories listed for Type 422 above plus slide-out tracks (351-0100-00); and mounting hardware.

TYPE R422 MOD 150E OSCILLOSCOPE **$1575**

OSCILLOSCOPES SIDE BY SIDE, MOD 150B

Two Type 422's mounted in a rackmount panel include two sets of accessories listed for Type 422 above plus slide-out tracks (351-0100-00); and mounting hardware.

TYPE R422 MOD 150B OSCILLOSCOPE **$3050**

OSCILLOSCOPE WITHOUT CABINET, MOD 146B

Type 422 Oscilloscope without cabinet for rackmount conversion includes accessories listed for Type 422.

TYPE 422 MOD 146B OSCILLOSCOPE **$1475**

CONVERSION KITS

TABLE TO RACKMOUNT CONVERSION KIT

This mounting kit includes hardware and instructions to convert existing Type 422 Oscilloscopes (AC version) for rackmount installation. Order 040-0419-00 . . . . . $95

RACKMOUNT TO PORTABLE CONVERSION KIT

This kit includes the cabinet and necessary hardware to convert existing Type R422 Oscilloscopes for portable operation. Order 040-0421-00 . . . . . $66

OPTIONAL ACCESSORIES

This listing covers only the more commonly used items. The standard probes (10X) supplied with the instrument satisfy most measurement requirements. In addition to the listed optional probes, other probes are available for current and high-voltage measurements. A complete list of accessory items can be found in the catalog accessory pages.

C-30A COMPACT CAMERA

f/1.9 lens, magnification variable from 1.5:1 to 0.7:1, Polaroid Land* Pack-Film back for 3000-speed film, order C-30A-P $480

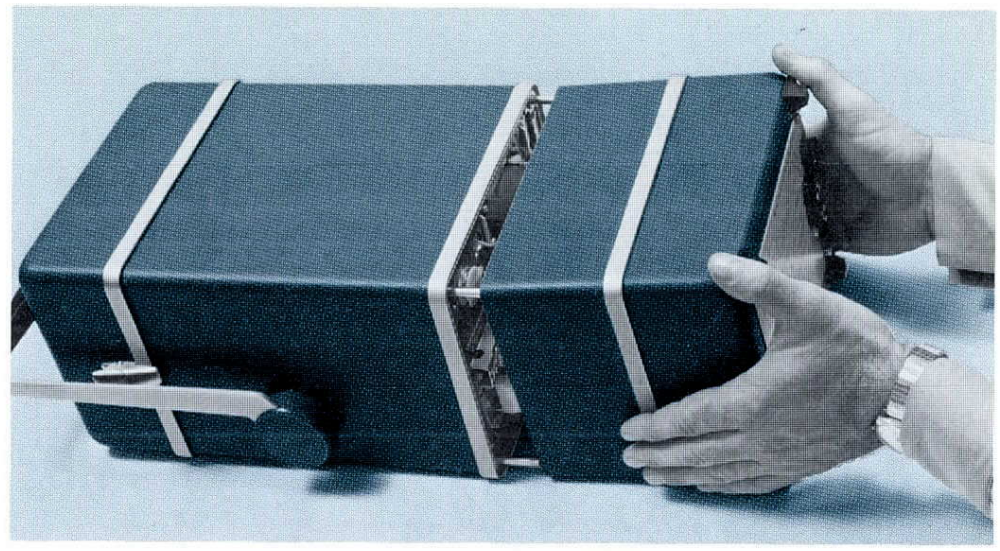
PROBES

P6007 100X Probe Package, order 010-0150-00 . . . . . $29.00
P6011 1X Miniature Probe Package, order 010-0193-00 $21.00

OSCILLOSCOPE COVER

Provides protection for Type 422 during transport or storage.

Type 422 (with battery pack) COVER, 016-0075-00 . . . . $8.00
Type 422 (without battery pack) COVER, 016-0076-00 . . $8.00



AC/DC POWER SUPPLY WITHOUT BATTERY PACK

Converts Type 422 Portable Oscilloscope for DC or (with battery pack) battery operation.

Domestic shipping weight 10¼ lbs.

Includes: 3 to 2-wire adapter (103-0013-00); power cord, 3-wire AC w/female connector and male plug (161-0015-01); power cord, 3-wire DC w/female connector (161-0016-01); two instruction manuals (070-0895-00).

Order 016-0073-00 . . . . . $660

COLLAPSIBLE VIEWING HOOD

Permits viewing of trace under high ambient-light conditions, order 016-0082-00 . . . . . $9.00

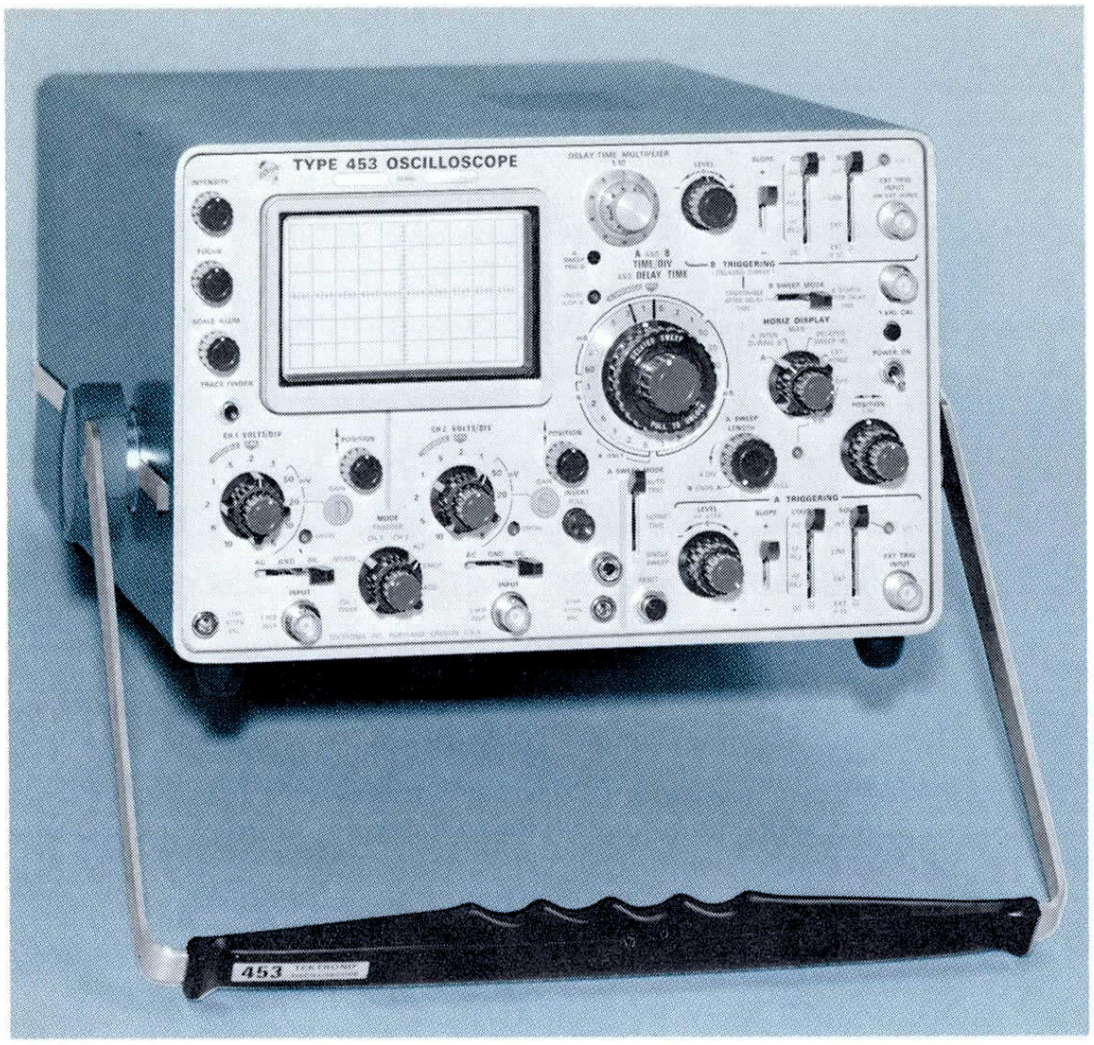
SCOPE-MOBILE® CART

Type 200-2 occupies less than 18-inches aisle space, has storage space in base $95

*Registered Trademark Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

453 50-MHz Dual-Trace Portable Oscilloscopes R453



- *7-ns RISETIME WITH OR WITHOUT PROBE*
- *COMPACT, LIGHT WEIGHT*
- *DUAL-TRACE, 5-mV/DIV DEFLECTION FACTOR*
- *CALIBRATED SWEEP DELAY*
- *FULL-BANDWIDTH TRIGGERING*
- *FULL-SENSITIVITY X-Y DISPLAY*
- *FOR SEVERE ENVIRONMENTS*
- *ILLUMINATED PARALLAX-FREE GRATICULE*

The Type 453 is a portable, wide-band, dual-trace oscilloscope designed to withstand rough transport and other environmental extremes. Bandwidth of the Type 453 is DC to 50 MHz (with or without supplied probes). Probes are miniaturized for easy access to dense circuitry.

The sharply-focused, bright trace provides a high-definition display compatible with the wide-band capabilities of the Type 453.

Solid-state design, with FET inputs, provides low drift and fast stabilization time.

Mechanical design features include plug-in transistors (for ease of maintenance), a front-panel cover (for use in transit or storage) with storage space for accessory items, and a carrying handle which can be rotated to several positions as a tilt-stand or for convenient carrying.

Channel 1 can be switched to give horizontal deflection with Channel 2 providing the vertical deflection, enabling full-sensitivity X-Y displays (to 5 mV/div).

Type R453 is electrically identical to Type 453. It mounts on tilting, slide-out tracks to a standard 19-inch rack, requiring only 7 inches of vertical rack-space.

CHARACTERISTIC SUMMARY

VERTICAL

(2 Identical Channels)

BANDWIDTH & RISETIME
10 V/div to 20 mV/div: DC to 50 MHz, 7 ns
10 mV/div: DC to 45 MHz, 7.8 ns
5 mV/div: DC to 40 MHz, 8.75 ns

CALIBRATED DEFLECTION FACTOR — 5 mV/div to 10 V/div. 50 mV/div to 100 V/div with P6010 Probe.

INPUT RC—1 megohm paralleled by approx 20 pF.

HORIZONTAL

CALIBRATED TIME BASE — 0.1 μs/div to 5 s/div.

X10 MAGNIFIER — Operates over full time base, increases fastest rate to 10 ns/div.

CALIBRATED SWEEP DELAY—1 μs to 50 s.

EXTERNAL INPUT — 270 mV/div to 2.7 V/div, or Channel 1 can drive HORIZONTAL.

CRT

DISPLAY AREA — 6 x 10 div (0.8 cm/div).

ACCELERATING VOLTAGE — 10 kV.

PHOSPHOR—P31.

OTHER

AMPLITUDE AND TIME CALIBRATOR—1 V or 0.1 V output; 5 mA output; 1-kHz squarewave.

POWER REQUIREMENTS— 90 to 136 V or 180 to 272 V, 48 to 440 Hz, 92 watts maximum.

VERTICAL DEFLECTION

(2 identical channels)

BANDWIDTH* AND RISETIME	
DEFLECTION FACTOR**	FROM 50-Ω TERMINATED SOURCE WITH OR WITHOUT P6010 PROBE
10 V/div to 20 mV/div	DC to at least 50 MHz, 7 ns
10 mV/div	DC to at least 45 MHz, 7.8 ns
5 mV/div	DC to at least 40 MHz, 8.75 ns
1 mV/div Ch 1 & 2 Cascaded	DC to at least 25 MHz, 14 ns

*Measured at 3-dB down. Lower 3-dB point, AC coupled is approx 1.6 Hz (approx 0.16 Hz with P6010 10X Probe).

**Without P6010 10X Probe. Deflection factor with P6010 is 10X panel reading.

DEFLECTION FACTOR (EACH CHANNEL)

5 mV/div to 10 V/div in 11 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated continuously variable between steps and to ≈25 V/div. Warning lights indicate uncalibrated settings.

TRACE DRIFT		
DEFLECTION FACTOR	TIME	TEMPERATURE
5 mV/div	less than 0.08 div/h	less than 0.02 div/°C
10 mV/div	less than 0.05 div/h	less than 0.0125 div/°C
20 mV/div through 10 V/div	less than 0.03 div/h	less than 0.0075 div/°C

INPUT RC

1 megohm ±2% paralleled by 20 pF ±3%.

MAXIMUM INPUT VOLTAGE

600 V combined DC + peak AC.

OPERATING MODES

Channel 1 only; Channel 2 only (normal or inverted); Added algebraically (common-mode rejection ratio at least 20:1 at 20 MHz with 160 mV P-P of common-mode signal at 20 mV/div); Alternate; Chopped at a 500 kHz (±20%) rate.

DELAY LINE

Permits viewing of leading edge of triggering waveform.

SIGNAL OUTPUT

Channel 1 Vertical Signal: ≥25 mV/div into 1 megohm; approx 50-Ω output resistance; DC to ≥25 MHz (—3 dB).

INTERNAL TRIGGER SOURCE

Normal (displayed signal) or Channel 1 signal only picked off ahead of channel switching.

HORIZONTAL DEFLECTION

TIME BASE A

0.1 μs/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). Uncalibrated continuously variable between steps and to 12.5 s/div. Warning light indicates uncalibrated setting. Sweep length continuously variable from ≤4 div to 11.0 ±0.5 div.

TIME BASE B

0.1 μs/div to 0.5 s/div in 21 calibrated steps (1-2-5 sequence). Uncalibrated continuously variable between steps and to ≥1.25 s/div. Warning light indicates uncalibrated setting.

TIME BASE A & B SWEEP ACCURACY (center 8 div)		
SWEEP RANGE	0°C to 40°C	—15°C to +55°C
0.1 μs/div to 50 ms/div	±3%	±4%
0.1 s/div to 5 s/div	±3%	±5%

X10 MAGNIFIER

Operates over full time base, increases fastest rate to 10 ns/div. Magnified display accurate within 1% in addition to specified basic sweep accuracy.

TIME BASE A SWEEP MODES

Auto Trigger—sweep free runs in absence of triggering signal; Normal Trigger; Single Sweep. Light indicates when sweep is triggered.

TIME BASE B SWEEP MODES

Time Base B Triggerable after delay time; Time Base B starts after delay time.

TRIGGER

TIME BASE A & B TRIGGER SENSITIVITY		
TRIGGER MODE	TO 10 MHz	AT 50 MHz
DC INTERNAL	≤0.2 div deflection	≤1 div deflection
DC EXTERNAL	≤50 mV	≤200 mV
AC	Requirements increase below 30 Hz	
AC LF REJECT	Requirements increase below 30 kHz	
AC HF REJECT	Requirements increase below 30 Hz and above 50 kHz	

SOURCES

Internal, Line, External, External ÷ 10.

Input RC approx 1 megohm paralleled by approx 20 pF (except in AC LF Reject mode). 600 volts maximum input (DC + peak AC). Level adjustment through ≥ ±2 volts in External, through ≥ ±20 volts in External ÷ 10.

X-Y OPERATION

FULL-SENSITIVITY X-Y (CH 1 HORIZ, CH 2 VERT)

5 mV/div to 10 V/div in 11 calibrated steps (1-2-5 sequence), accurate within 5% from 0° C to +40° C within 8% from —15°C to +55°C; no variable on Ch 1. Bandwidth is DC to ≥5 MHz (—3 dB). Phase difference between amplifiers is ≤3° at 50 kHz.

HORIZONTAL AMPLIFIER (EXTERNAL INPUT)

270 mV/div ±15% in External, 2.7 V/div ±20% in External ÷10. Same bandwidth and phase difference as above.

CALIBRATED SWEEP DELAY

DELAY RANGE

0.2 μs to 50 s after delaying sweep start.

DELAY ACCURACY		
DELAY TIME SETTING	0°C to +40°C	−15°C to +55°C
1 μs to 50 ms 0.1 s to 5 s	Within 1.5% Within 2.5%	Within 2.0% Within 3.5%
MULTIPLIER	Within 0.2% of full scale (2 minor dial divisions)	Within 0.3% of full scale (3 minor dial divisions)
DIFFERENTIAL TIME MEASUREMENT		
1 μs to 50 ms	Within 1.5% and 4 minor dial divisions	Within 2% and 6 minor dial divisions
0.1 s to 5 s	Within 2.5% and 4 minor dial divisions	Within 3.5% and 6 minor dial divisions

JITTER
1 part or less in 20,000 of 10X DELAY TIME.

ENVIRONMENTAL CAPABILITIES

AMBIENT TEMPERATURE
Operating: −15°C to +55°C.
Non-operating: −55°C to +75°C.

ALTITUDE
Operating: 15,000 feet; maximum allowable ambient temperature decreased 1°C/1000 feet from 5,000 to 15,000 feet.
Non-operating: 50,000 feet.

VIBRATION
Operating: 15 minutes along each of the three axes, 0.025 inch peak to peak displacement (4 g's at 55 c/s) 10 to 55 to 10 c/s in 1-minute cycles.

SHOCK
Operating and non-operating: 30 g's, ½ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

ELECTROMAGNETIC INTERFERENCE (Type 453 MOD 163D and R453 MOD 163D only)
Meets interference requirements of MIL-I-6181D and MIL-I 16910C, power line conducted: 150 kHz to 30 MHz, radiated (with mesh filter installed): 14 kHz to 1 GHz.

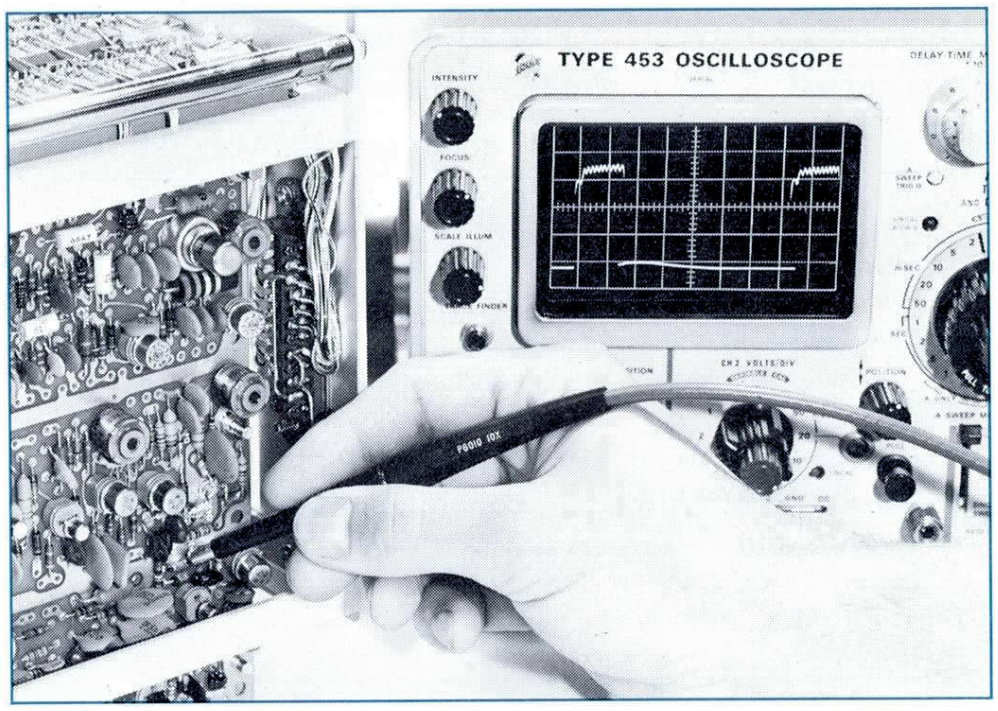
HUMIDITY
Operating and storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F.

CRT

TEKTRONIX CRT
4-inch rectangular tube; 6 x 10 div (each div = 0.8 cm) display area; P31 phosphor normally supplied; P1, P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. 10-kV accelerating potential. Z-axis input DC coupled to CRT; noticeable modulation at normal intensity with 5 volts or more peak to peak; DC to ≥50 MHz usable frequency range; maximum input voltage, 200 volts (DC plus peak AC).

GRATICULE
Internal, parallax-free; variable edge lighting.

TRACE FINDER
Compresses display to within graticule area, for ease in determining the location or relative magnitude of an off-screen signal.



Small probe for easy access to dense circuitry.

OTHER CHARACTERISTICS

AMPLITUDE AND TIME CALIBRATOR
1 volt or 0.1 volt output; 5-mA output. Amplitude accurate within 1% from 0° C to +40° C, within 1.5% from −15° C to +55°C. 1-kHz squarewave, repetition rate accurate within 0.5% from 0° C to +40° C, within 1% from −15° C to +55°C. ≤1-μs risetime; 49% to 51% duty cycle.

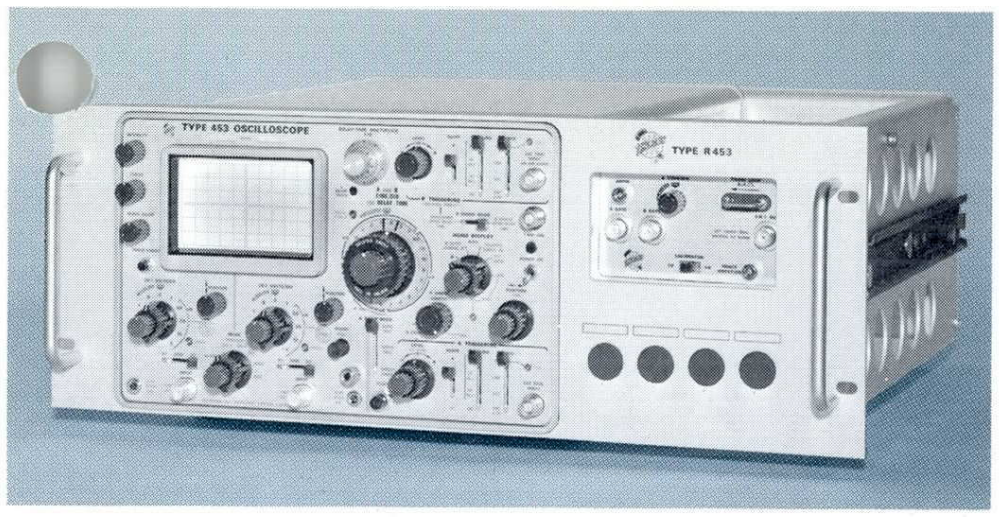
SIGNAL OUTPUTS
A and B Gates: 12 volts ±10%, approx 1.5-kΩ output resistance.

POWER REQUIREMENTS
Quick-change line-voltage selector provides 6 ranges: 90 to 110 V, 104 to 126 V, 112 to 136 V, 180 to 220 V, 208 to 252 V, and 224 to 272 V. 48 to 440 Hz, 92 watts maximum at 115 V and 60 Hz.

COOLING
Filtered forced-air cooling.

DIMENSIONS AND WEIGHTS (Type 453)

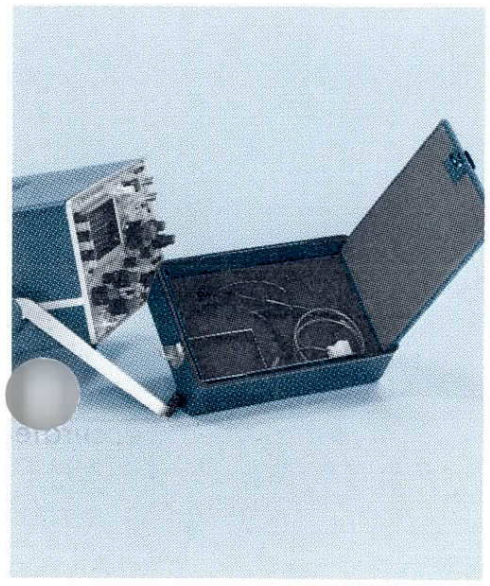
Height	7¼ in	18.4 cm
Width	12½ in	30.8 cm
Depth (including panel cover)	20½ in	52.0 cm
Depth (with extended handle)	22⅜ in	56.8 cm
Net weight (without panel cover)	27¾ lb	12.6 kg
Weight (with panel cover and accessories)	30 lb	13.6 kg
Weight (with dust and rain cover, power cord, and one instruction manual)	32 lb	14.6 kg
Domestic shipping weight	≈42 lb	≈19.1 kg
Export-packed weight	≈54 lb	≈24.6 kg

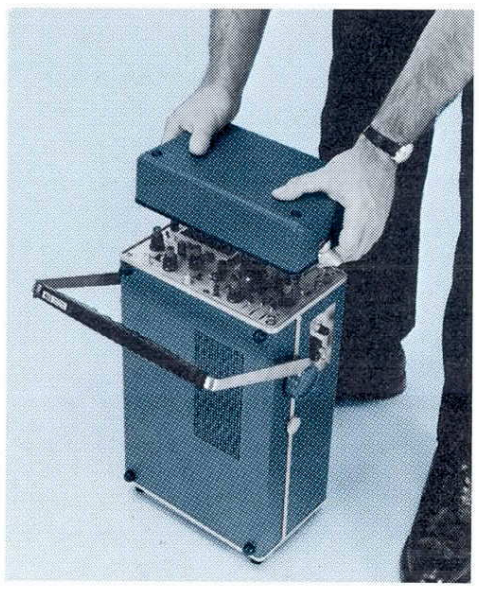


Type R453 Oscilloscope

DIMENSIONS AND WEIGHTS (Type R453)

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Depth (behind front panel)	17¾ in	45.0 cm
Net weight	32¼ lb	14.7 kg
Domestic shipping weight	≈63½ lb	≈28.8 kg
Export-packed weight	≈87 lb	≈39.6 kg





Panel cover provides storage for standard accessories.

INCLUDED STANDARD ACCESSORIES

Two P6010 3.5-ft 10X probe package (010-0188-00); 18-inch 50-Ω BNC cable (012-0076-00); BNC jack post (012-0092-00); 3 to 2-wire adapter (103-0013-00); CRT ornamental ring (354-0269-00); smoke-gray light filter (378-0576-00); mesh filter, installed (378-0623-00); CRT face-plate protector (386-0218-00); oscilloscope dust and rain cover (016-0074-01); two BNC to binding post adapters (103-0033-00); five fuses, assorted spares; two instruction manuals (070-0755-00). Accessories for R453 are the same as for Type 453 less dust and rain cover, but also includes: mounting hardware; slide-out tracks (351-0101-00).

TYPE 453 OSCILLOSCOPE $2050
TYPE R453 OSCILLOSCOPE $2135

TYPE 453 AND TYPE R453 MOD 163D

Includes the features of the standard Type 453 and R453, and in addition meets electromagnetic interference requirements of MIL-I-6181D and MIL-I-16910C; Power line conducted: 150 kHz to 30 MHz; Radiated (with mesh filter installed): 14 kHz to 1 GHz.

E 453 MOD 163D OSCILLOSCOPE $2150
TYPE R453 MOD 163D OSCILLOSCOPE $2235

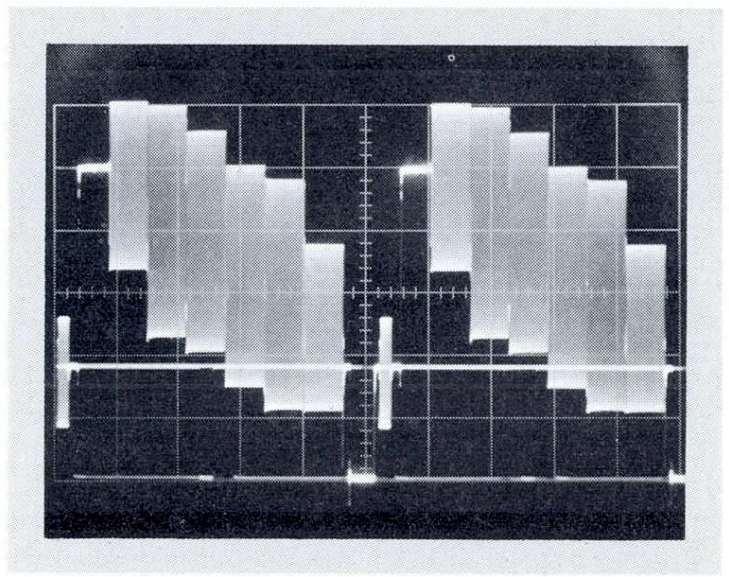
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

TYPE 453 AND R453 MOD 127C

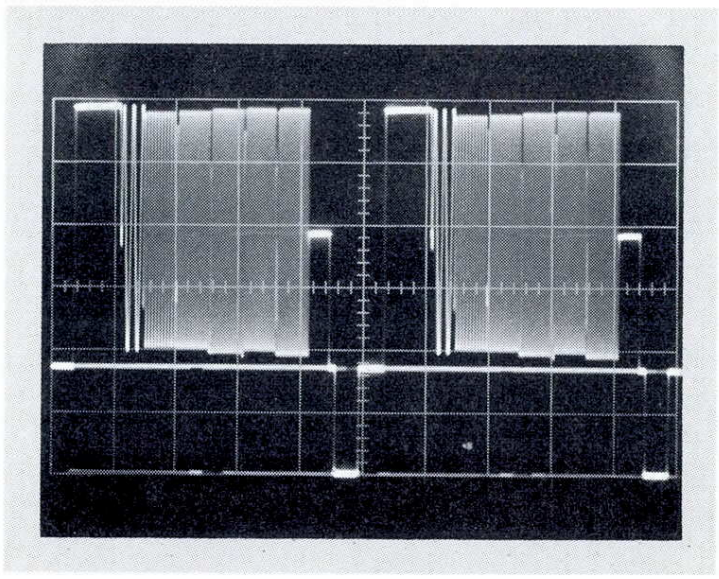
An internal TV Sync Separator circuit permits stable internal Line or Field-rate triggering from displayed composite video or composite sync waveforms. External ÷ 10 trigger sources are replaced by internal TV Sync positions providing Line (Horizontal) sync pulses to the B Sweep circuit and either Field (Vertical) or Line sync pulses to the A Sweep circuit.

Individual line selection of VIT (vertical interval test) signals is facilitated by the sweep delay features in the Type 453. The wide range of sweep delays permit accurate alternate-frame color-burst observations in the PAL color system.

Conventional waveform displays and measurements can be made from standard broadcast or closed-circuit TV systems, domestic or overseas, with up to 1201-line, 60-Hz field rates. A parallax-free, 6 x 10 div, edge-lighted graticule is standard. Two additional snap-in TV graticules are supplied for viewing convenience but may not be edge lighted. Other characteristics are the same as Type 453 and R453.



NTSC color bar test signal displayed on the Type 453 MOD 127C.



Multiburst test signal displayed on the Type 453 MOD 127C.

INCLUDED STANDARD ACCESSORIES

Same as Type 453 except as follows: delete two P6010 3.5 ft 10X probe packages (010-0188-00), add two P6010 6 ft probe packages (010-0185-00), two 6-32 adapters (103-0051-00), two spring phone tip adapters (206-0060-00), snap-in light filter/TV graticule (NTSC) 378-0576-04, snap-in light filter/TV graticule (CCIR) 378-0576-05.

TYPE 453 MOD 127C $2135
TYPE R453 MOD 127C $2220

Accessories on next page.

CONVERSION KIT

PORTABLE TO RACKMOUNT

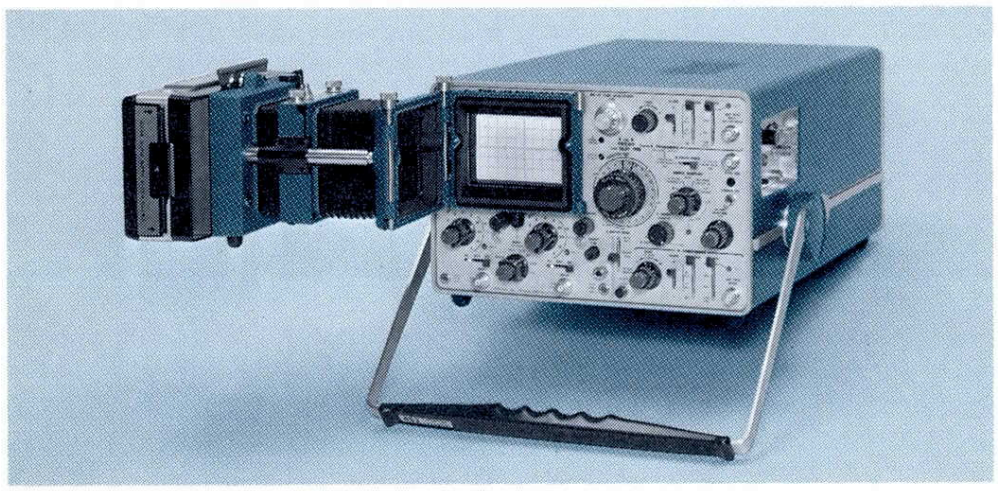
Includes hardware and instructions to convert existing Type 453 Portable Oscilloscopes for rack-mount installation.
Order 040-0446-01 ..... $110

OPTIONAL ACCESSORIES

Optional accessories serve to extend the usefulness of the Type 453 in certain applications. This list covers only the more commonly used items. The standard probes (10X) supplied with the instrument satisfy most measurement requirements. In addition to the listed optional probes, other probes are available for current and high-voltage measurements. See catalog accessory pages.

COLLAPSIBLE VIEWING HOOD

Permits viewing of trace under high ambient-light conditions.
Order 016-0083-00 ..... $9.00



The Type 453 with the Tektronix C-31.

C-31 COMPACT CAMERA

f/1.2, 1:0.5 lens with Roll-Film back for 10,000 or 3000-speed film, order C-31-R $585

PROBES

P6010 6 ft 10X Probe Package, order 010-0185-00 .... $[illegible]
P6011 3.5 ft 1X Probe Package, order 010-0193-00 ... $21.00

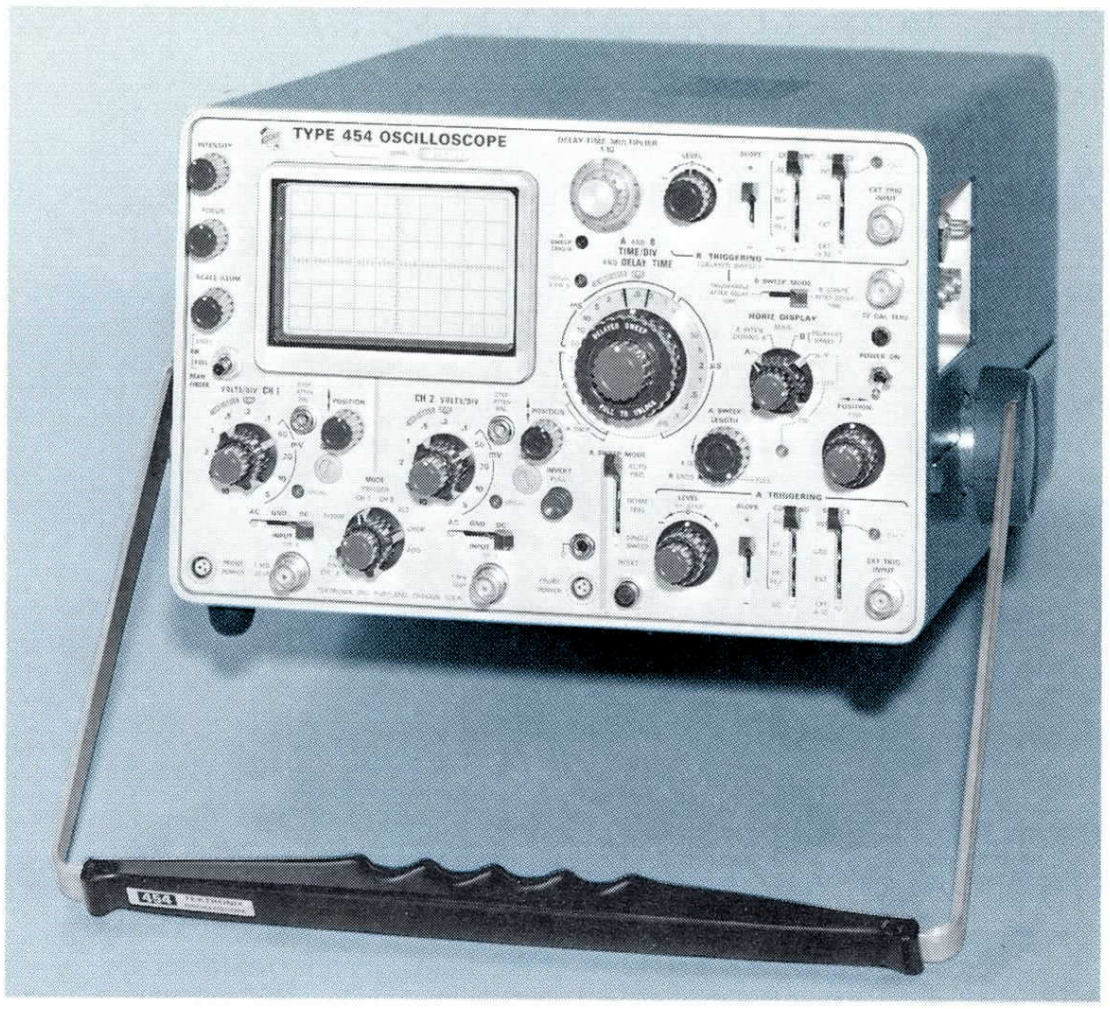
SCOPE-MOBILE® CART

Type 200-1 occupies less than 18 inches aisle space, has storage space at base $95.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

454 150-MHz Dual-Trace Portable Oscilloscopes R454

- *2.4-ns RISETIME WITH OR WITHOUT PROBE*
- *HIGH-WRITING-SPEED CRT*
- *DUAL-TRACE, 5-mV/DIV DEFLECTION FACTOR*
- *FULL-BANDWIDTH TRIGGERING*
- *CALIBRATED SWEEP DELAY*
- *FULL-SENSITIVITY X-Y DISPLAYS*
- *COMPACT, RUGGED CONSTRUCTION*
- *SOLID-STATE DESIGN*



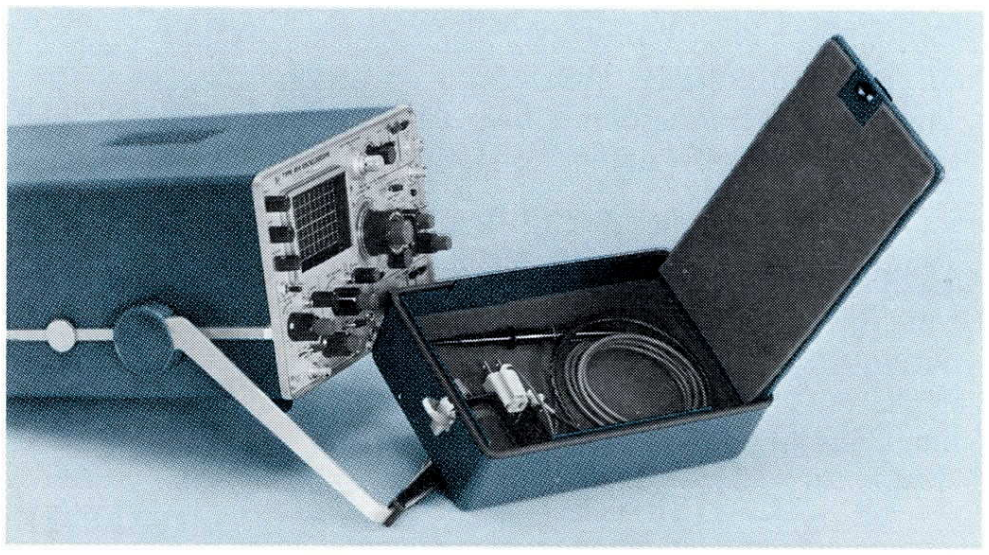
The Type 454 offers convenient measurement of fast-rise pulses and high-frequency signals previously beyond the capability of most conventional real-time oscilloscopes. Risetime is 2.4 ns, bandwidth is 150 MHz, with or without probe.

The two channels of the Type 454 provide cascaded single-[illegible] displays at 1 mV/div, and also provide X-Y displays to 5 mV/div. The dual-trace vertical system displays either channel separately, adds channels algebraically, alternates between channels, or chops between channels at a 1-MHz rate.

A time-base system with calibrated sweep delay permits highly-magnified displays of small portions of undelayed sweeps, accurate measurement of waveform time jitter, precise time measurements, and many other measurement uses.

The Type 454 is mechanically designed to withstand environmental extremes and rough handling in transit. Plug-in transistors provide ease of maintenance.

Type R454 (the rackmount model) is electrically identical to Type 454, but is mechanically designed to mount on tilting slide-out tracks in a standard 19-in rack.



[illegible] cover provides storage for standard accessories.

CHARACTERISTIC SUMMARY

VERTICAL

(2 identical channels)

BANDWIDTH & RISETIME
10 V/div to 20 mV/div: DC to 150 MHz, 2.4 ns
10 mV/div: DC to 100 MHz, 3.5 ns
5 mV/div: DC to 60 MHz, 5.9 ns

CALIBRATED DEFLECTION FACTORS—5 mV/div to 10 V/div, 11 steps; 50 mV/div to 100 V/div with P6047 Probe.

INPUT RC—1 megohm paralleled by 20 pF.

HORIZONTAL

CALIBRATED TIME BASE—0.05 μs/div to 5 s/div, 25 steps.

TRIGGERING—DC to 150 MHz.

X10 MAGNIFIER—Operates over full time base, increases fastest rate to 5 ns/div.

CALIBRATED SWEEP DELAY—1 μs to 50 s.

X-Y OPERATION—5 mV/div to 10 V/div, DC to 2 MHz.

CRT

DISPLAY AREA—6 x 10 div (0.8 cm/div), internal graticule.

ACCELERATING VOLTAGE—14 kV.

PHOSPHOR—P31.

OTHER

AMPLITUDE AND TIME CALIBRATOR—1 V, 5 mA; 1 kHz.

PROBE POWER—2 connectors for P6045 FET Probe power.

POWER REQUIREMENTS—90 to 136 V and 180 to 272 V in six ranges; range selection via quick-change switching device. 48 to 440 Hz, approx 125 watts.

VERTICAL DEFLECTION SYSTEM

(2 identical channels)

BANDWIDTH* AND RISETIME (0°C to +40°C)			
FROM 50-Ω TERMINATED SOURCE			
DEFLECTION FACTOR**	with or without P6047 PROBE	WITH P6045 FET PROBE	WITH P6048 10X PROBE
10 V/div to 20 mV/div	150 MHz and 2.4 ns	130 MHz and 2.7 ns	100 MHz and 3.5 ns
10 mV/div	100 MHz and 3.5 ns	95 MHz and 3.7 ns	75 MHz and 4.7 ns
5 mV/div	60 MHz and 5.9 ns	58 MHz and 6 ns	45 MHz and 7.8 ns
1 mV/div Ch 1 & 2 Cascaded	33 MHz and 11 ns	30 MHz and 12 ns	30 MHz and 12 ns

*Measured at 3-dB down. Lower 3-dB point, AC coupled is less than 10 Hz (less than 1 Hz with P6047 10X Probe).

**Oscilloscope only. Deflection factor with P6047 or P6048 Probe is 10X panel reading.

PROBE DATA—P6047 10X Passive Probe (supplied with Type 454): 10X attenuation, 10 megohms input resistance, and 10 pF input capacitance. P6045 1X FET Active Probe (extra-cost option): 1X attenuation, 10 megohms input resistance, and less than 5.5 pF input capacitance. P6048 10X Passive Probe (extra-cost option): 10X attenuation, 1 kΩ input resistance, and 1 pF input capacitance. See catalog accessory page for additional data.

PROBE POWER

Two connectors provide correct operating voltages for two P6045 FET Probes.

TRACE FINDER—5-MHz BANDWIDTH SWITCH

Down position compresses display to within graticule area for convenient trace location. Up position limits bandwidth of main vertical amplifier to between 4 and 6 MHz for noise and interference reduction at higher sensitivities. Center position provides normal operation.

DEFLECTION FACTOR (2 identical channels)

5 mV/div to 10 V/div in 11 calibrated steps (1-2-5 sequence), accurate within ± 3%. Continuously variable (uncalibrated) between steps and to approx 25 V/div. Warning lights indicate uncalibrated settings.

ABERRATIONS (Measured from a 50-Ω terminated source)	
DEFLECTION FACTOR	Aberrations occuring during the 50 ns following the 50% amplitude point on a positive-going (noninverted) step, without probe, after a 20-minute warm-up at 20° C to 30° C ambient temperature.
100 mV/div	+7% or less, —7% or less, total 7% or less P-P.
50 and 20 mV/div	+5% or less, —5% or less, total 5% or less P-P.
10 mV/div	+6% or less, —6% or less, total 6% or less P-P.
5 mV/div	+7% or less, —7% or less, total 7% or less P-P.

INPUT RC

1 megohm ± 2%, paralleled by 20 pF ± 1 pF.

MAXIMUM INPUT VOLTAGE

600 V (DC + peak AC), 600 V (P-P AC) at 1 kHz or less.

OPERATING MODES

Channel 1 only; Channel 2 only (normal or inverted); Ad[illegible] algebraically (common-mode rejection ratio at least 10:[illegible] 50 MHz with 400 mV P-P of common-mode signal at 50 mV/div); Alternate; Chopped at 1 MHz (± 20%).

TIME DELAY BETWEEN CHANNELS

0.25 ns or less.

DELAY LINE

Permits viewing leading edge of triggering waveform.

SIGNAL OUTPUT

Channel 1 vertical output: ≥ 25 mV per division of Channel 1 display (into 1 megohm); approx 30-Ω output resistance; DC to ≥ 33 MHz (3-dB down).

INTERNAL TRIGGER SOURCE

Normal (displayed signal) or Ch 1 signal only picked off ahead of channel switching.

HORIZONTAL DEFLECTION SYSTEM

TIME BASE A

0.05 μs/div to 5 s/div in 25 calibrated steps (1-2-5 sequence). Continuously variable (uncalibrated) between steps and to approx 12.5 s/div. Warning light indicates uncalibrated setting. Sweep length continuously variable from ≤ 4 div to 11.0 div ± 0.5 div.

TIME BASE B

0.05 μs/div to 0.5 s/div in 22 calibrated steps (1-2-5 sequence). Continuously variable (uncalibrated) between steps and to approx 1.25 s/div. Warning light indicates uncalibrated setting.

X10 MAGNIFIER

Operates over full time base, increases fastest rate to 5[illegible] div.

TIME BASE A & B SWEEP ACCURACY (center 8 div)				
SWEEP TIME/DIV	0°C to +40°C		—15°C to +55°C	
	Normal	Magnified	Normal	Magnified
0.05 μs	±3%	±4%	±4%	±6%
0.1 μs to 0.5 s			±4%	±5%
1 s to 5 s			±5%	±6%

HORIZONTAL-DISPLAY MODES

Time Base A only, A Intensified During B, B (delayed sweep), and X-Y (switches Channel 1 to drive X axis).

TIME BASE A SWEEP MODES

Repetitive sweep with automatic triggering, repetitive sweep with normal triggering, or single sweep for photographic recording. Light indicates when sweep is triggered.

TIME BASE B SWEEP MODES

Time Base B triggerable after delay time, or Time Base B runs automatically at end of delay time.

X-Y OPERATION

FULL-SENSITIVITY X-Y (CH 1 HORIZ, CH 2 VERT)

5 mV/div to 10 V/div in 11 calibrated steps (1-2-5 sequence), accurate within ±3%; no variable on Ch 1. X bandwidth is DC to ≥ 2 MHz (3-dB down). Phase difference between amplifiers is ≤ 3° from DC to 2 MHz.

CALIBRATED SWEEP DELAY

DELAY RANGE

0.1 μs to 50 s after delaying sweep start.

JITTER

1 part or less in 20,000 of 10X DELAY TIME.

DELAY ACCURACY		
DELAY TIME SETTING	0°C to +40°C	−15°C to +55°C
1 μs to 50 ms 0.1 s to 5 s	Within 1.5% Within 2.5%	Within 2.0% Within 3.5%
MULTIPLIER	Within 0.2% of full scale (2 minor dial divisions)	Within 0.3% of full scale (3 minor dial divisions)
DIFFERENTIAL TIME MEASUREMENT		
1 μs to 50 ms	Within 1.5% and 4 minor dial divisions	Within 2% and 6 minor dial divisions
0.1 s to 5 s	Within 2.5% and 4 minor dial divisions	Within 3.5% and 6 minor dial divisions

TRIGGERING

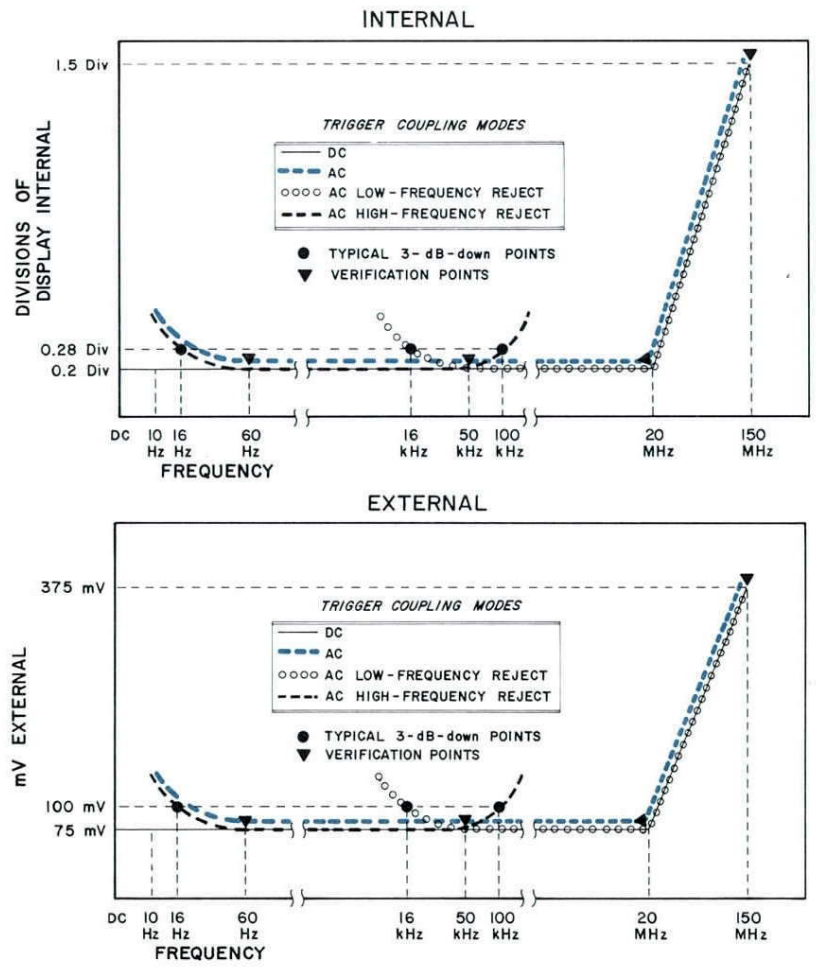
MODES

Automatic or Normal on Time Base A. Automatic operation useful between 20 Hz and 150 MHz, minimizes trigger adjustments for signals of different amplitudes, shapes and repetition rates. With no input (or input less than 20 Hz), the automatic triggering free runs the sweep and provides a bright reference trace at all sweep rates. Normal triggering only on Time Base B. With sweep delay, Time Base B can be set to run at end of delay period, or to be triggerable at end of delay period.

...ER

...ns or less at 150 MHz.

SIGNAL REQUIREMENTS, TIME BASE A & B



COUPLING, TIME BASE A & B

..., DC, AC Low-Frequency Reject, or AC High-Frequency Reject.

SOURCES, TIME BASE A & B

Internal, External, External ÷ 10, or Line. 500-V maximum input (DC + peak AC). Level adjustment through at least ± 2 volts in External, through at least ± 20 volts in External ÷ 10.

CONVENIENT SWITCH LOGIC

Trigger switches are arranged with the up position providing the most commonly used set of trigger functions: Automatic mode, + slope, AC coupling and Internal source.

ENVIRONMENTAL CAPABILITIES

(Oscilloscope and P6047 Probe)

AMBIENT TEMPERATURE

Operating: −15°C to +55°C. Nonoperating: −55°C to +75°C.

ALTITUDE

Operating: To 15,000 feet; maximum allowable ambient temperature decreased by 1°C/1000 feet from 5,000 to 15,000 feet. Nonoperating: to 50,000 feet.

VIBRATION

Operating: 15 minutes along each of the three axes, 0.025 inch peak-to-peak displacement (4 g's at 55 c/s) 10 to 55 to 10 c/s in 1-minute cycles.

SHOCK

Operating and nonoperating: 30 g's, ½ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

ELECTROMAGNETIC INTERFERENCE (Type 454 MOD 163D and R454 MOD 163D only)

Meets interference requirements of MIL-I-6181D and MIL-I-16910C, power line conducted: 150 kHz to 30 MHz, radiated (with mesh filter installed): 14 kHz to 1 GHz.

HUMIDITY

Operating and storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F.

PHOTOGRAPHIC WRITING SPEED

(without Film Fogging Techniques)

Camera and Phosphor					Minimum Photographic Writing Speed
Camera	Lens	Object-to-image ratio	Polaroid* film type	CRT Phosphor	
C-31-R	f1.2	1:0.5	410 (10,000 ASA)	P31	1600 div/μs (1280 cm/μs)
				P11	3200 div/μs (2560 cm/μs)
C-30A	f1.9	1:0.7	107 (3,000 ASA)	P31	182 div/μs (146 cm/μs)

*Registered Trademark, Polaroid Corporation

454 150-MHz Dual-Trace Portable Oscilloscopes R454

CRT

TEKTRONIX CRT

4-in rectangular tube; 6 x 10 div display area, each div is 0.8 cm, horizontal and vertical centerlines further marked in 0.2-div increments. P31 phosphor normally supplied; P1, P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. 14-kV accelerating potential. Z-axis input DC coupled to CRT cathode; noticeable modulation at normal intensity with 5-V or more peak-to-peak signal; DC to 50 MHz usable frequency range; maximum input voltage 200 V (DC plus peak AC), P-P AC 200 V or less, 1 kHz or less.

GRATICULE

Internal, no parallax; variable edge lighting.

OTHER CHARACTERISTICS

AMPLITUDE AND TIME CALIBRATOR

1 V and 5 mA at external jacks; accurate within 1% from 0°C to +40°C, and within 1.5% from —15°C to +55°C. 1-kHz repetition rate accurate within 0.5% from 0°C to +40°C, and within 1% from —15°C to +55°C. Risetime $\leq$ 1 μs, duty cycle 49% to 51%, output resistance 250 Ω $\pm$ 1%.

SIGNAL OUTPUTS

Positive gates from both time bases (12.6 V $\pm$ 10%), and a positive-going sawtooth from Time Base A (10 V $\pm$ 10%).

POWER REQUIREMENTS

Quick-change line-voltage selector provides six ranges: 90 to 110 V, 104 to 126 V, 112 to 136 V, 180 to 220 V, 208 to 252 V, and 224 to 272 V. 48 to 440 Hz, 125 watts maximum at 115 V and 60 Hz.

COOLING

Filtered, forced-air ventilation.

TYPE 454 DIMENSIONS AND WEIGHTS

Height	7¼ in	18.4 cm
Width	12½ in	30.8 cm
Depth (incl. panel cover)	20½ in	52 cm
Depth (handle extended)	22⅜ in	56.8 cm
Net weight (w/o panel cover)	29¼ lb	12.7 kg
Net weight (with panel cover and accessories)	31¼ lb	13.6 kg
Domestic shipping weight	≈43 lb	≈18.7 kg
Export-packed weight	≈57 lb	≈24.8 kg

TYPE R454 DIMENSIONS AND WEIGHTS

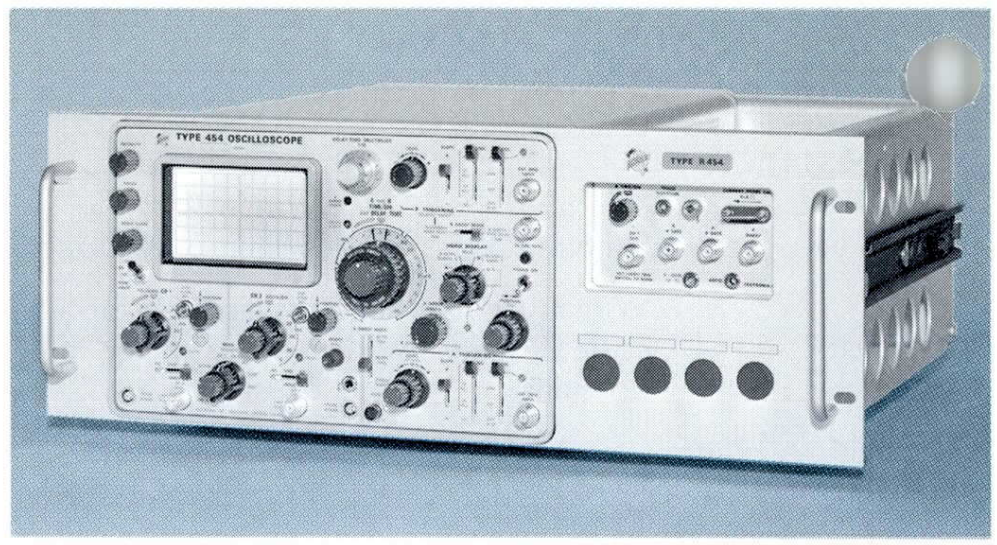
Height	7 in	17.8 cm
Width	19 in	48.3 cm
Depth (behind front panel)	17¾ in	45 cm
Net weight	33½ lb	14.5 kg
Domestic shipping weight	≈65 lb	≈28.2 kg
Export-packed weight	≈86 lb	≈37.4 kg

INCLUDED STANDARD ACCESSORIES

Two P6047 Probes with accessories (010-0211-00); 50-Ω 18-inch BNC cable (012-0076-00); BNC jack post (012-0092-00); 3 to 2-wire power-cord adapter (103-0013-00); CRT ornamental ring (354-0269-00); light filter, smoke-gray (378-0576-00); mesh filter, installed (378-0623-00); CRT faceplate protector (386-0218-00); two BNC binding-post adapters (103-0033-00); dust and rain cover (016-0074-01); two instruction manuals (070-0617-00); four fuses, assorted spares.

TYPE 454 OSCILLOSCOPE $2925

TYPE R454 OSCILLOSCOPE $3010



Type R454 Oscilloscope

CONVERSION KIT

PORTABLE TO RACKMOUNT

Includes hardware and instructions to convert existing Type 454 Portable Oscilloscope for rackmount installation.

Order 040-0446-01 ..... $110

TYPE 454 AND R454 MOD 163D

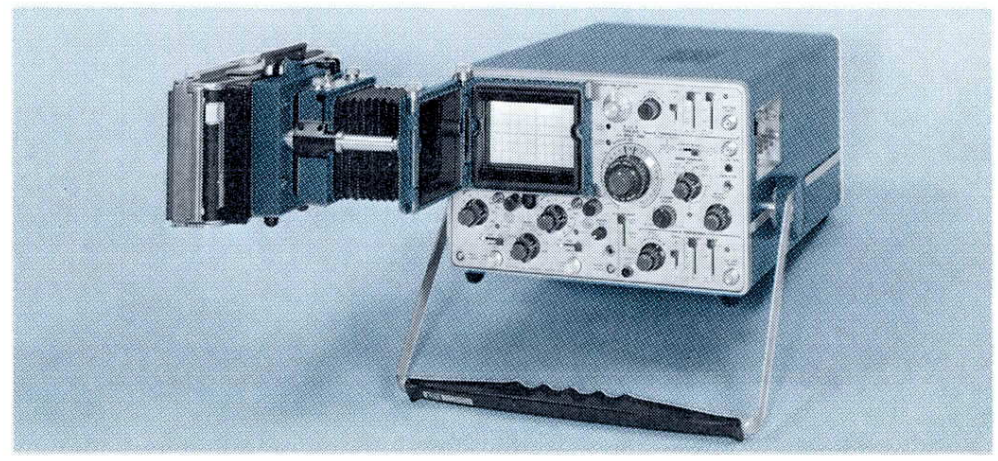
Includes the features of the standard Type 454 and R454, and in addition meets electromagnetic interference requirements of MIL-1-6181D and MIL-1-16910C; Power line conducted: 150 kHz to 30 MHz; Radiated (with mesh filter installed): 14 kHz to 1 GHz.

TYPE 454 MOD 163D OSCILLOSCOPE $3025

TYPE R454 MOD 163D OSCILLOSCOPE $3110

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability or provide added convenience. The standard probes supplied with the instrument satisfy most measurement requirements; optional probes, including high-voltage and current-measuring probes, may be better suited for particular applications. See catalog accessory pages.



The Type 454 with the Tektronix C-31-R.

C-31-R HIGH-SPEED CAMERA

f/1.2, 1:0.5 lens with Roll-Film back for 10,000 or 3000-speed film, order C-31-R $585

C-30A COMPACT CAMERA

f/1.9 lens, magnification variable from 1.5:1 to 0.7:1, Polaroid Land* Pack-Film back for 3000-speed film, order C-30A-P $480

PROBES

P6048 10X Probe Package, order 010-0215-00 ..... $ 61

P6045 1X FET Probe Package, order 010-0204-00 ..... $325

SCOPE-MOBILE® CART

200-1 is compact for easy maneuvering .....

*Registered Trademark, Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon

Please refer to Terms and Shipment, General Information page.

Spectrum Analyzer Reference & Contents

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SPECTRUM ANALYZER REFERENCE

Spectrum analysis may be defined as the study of the energy distribution of an electrical signal as a function of the frequencies within that signal. The information gained through spectrum analysis is frequently unobtainable by any other means. As a result, Spectrum Analyzers have developed into measurement tools which accurately provide information in an increasingly wide range of applications. Today, engineers and technicians are putting the spectrum analyzer into use in production, maintenance, in the laboratory and in the field.

Spectrum analyzers may be grouped into two general categories, (1) real time and (2) non-real time. Definitions of these analyzers are as follows:

A. Real Time Spectrum Analyzer—A spectrum analyzer that performs an analysis of the incoming signal with the time sequence of events preserved between input and output.

B. Non-Real Time—A spectrum analyzer that performs an analysis of a repetitive event by a sampling process.

Non-Real Time Analyzers are either swept front end or Swept IF.

1. Swept front end spectrum analyzer—A heterodyne spectrum analyzer in which the first local oscillator is swept.
2. Swept intermediate frequency spectrum analyzer—A heterodyne spectrum analyzer in which a local oscillator other than the first is swept.

Tektronix analyzers are Non-Real Time, either swept intermediate frequency or swept front end. They satisfy a broad range of measurement requirements and situations.

Plug-In Spectrum Analyzers

Present users of Tektronix Type 530, 540, 550, 560, and (with adapter) 580-Series Oscilloscopes can now achieve high-quality spectrum analysis at a cost less than that of other analyzers. In addition to cost, convenience is another significant advantage which oscilloscopes with plug-in analyzers offer over ordinary spectrum analyzers. The oscilloscope's calibrated time base and versatile triggering allow direct measurement of pulse repetition rate and provide stable displays even in the presence of interference. The oscilloscope powers the analyzer, and displays the spectrum on its CRT. A chart listing the presently available spectrum analyzer plug-ins and their more important specifications is included in this section.

Portable Spectrum Analyzers

The Type 491 is a compact, lightweight, self-contained, wide band spectrum analyzer designed for rugged environmental conditions and easy mobility. The display and analyzer circuitry is conveniently packaged in an easy-to-carry (38 lb) configuration. For very broadband analysis (up to 40 GHz), constant usage, rackmounting (7-inch height), or portable applications, the Type 491 is an ideal instrument.

Two modified 491 analyzers are available for applications which do not require the full 10 MHz-to-40 GHz center frequency range. The 491 MOD 139L has a center frequency range of 10 MHz to 2000 MHz and the 491 MOD 139M has a center frequency range of 1.5 GHz to 12.4 GHz (to 40 GHz with optional accessories).

Typically, the Spectrum Analyzer selects a portion of the electromagnetic spectrum—as wide as 100 MHz, for example—and displays visually on the oscilloscope CRT all the radio activity occurring there. Within the portion of the spectrum any signal, amplitude or frequency modulated, pulsed carriers, etc.—is displayed as a series of "pips" on the CRT. CALIBRATED DISPERSION permits detailed study of the signal, with frequency difference read directly from the CRT. Signals separated by 10 Hz can be resolved with the Type 1L5 or 1L10; signals separated by 1 kHz can be resolved with the Type 1L20, 1L40 or Type 491.

The dynamic range capability of the Tektronix Spectrum Analyzers is greatly increased by the inclusion of square-law and logarithmic detection modes as well as a linear mode. The ability to compress or expand signals enhances the versatility of these instruments. Signals of very nearly the same amplitude can be displayed in the SQUARE-LAW MODE which expands the small difference to a proportion that facilitates measurements. Conversely, signals of greatly different amplitude (40 dB, for example) can be displayed in the LOG MODE which compresses the difference between them. The Analyzers are extremely sensitive and will give usable displays with inputs lower than —100 dBm.

The usefulness of Tektronix Spectrum Analyzers extends into many measurement areas. They are used by government agencies to check the sidebands of radio-transmitting devices. Telephone companies find transmission-line carrier measurements quick and accurate, often providing data not obtainable by other means. Spectrum Analyzers are finding increased use in missile projects and the exploration of outer space, especially in association with the maintenance and trouble-shooting of telemetry equipment. They are indispensable to recently developed techniques of servicing radar and microwave equipment. The Type 1L5 extends spectrum analysis into lower-frequency applications including vibration studies, design of audio equipment, speech therapy, and others.

Spectrum Analyzer Reference & Contents

New uses are continuously being recognized for Spectrum Analyzers. A complete list of these applications would be impractical; therefore, the following limited list is intended only as an illustration of some of the typical analyzer applications.

Determining squegging of oscillators and regeneration in power amplifiers.

Checking the modulation characteristics of a video-modulated transmitter.

Troubleshooting a pulse-modulated transmitter.

May be used as a sensitive receiver.

Check automatic frequency control action.

Wavemeter calibration.

Detection of spurious transmitter frequencies.

Adjusting balanced modulators.

May be used as an aid in tuning oscillators.

Antenna-pattern measurements.

ECM measurements.

Pulse detection in the presence of FM.

AM and FM applications.

A listing of some of the more unusual Spectrum Analyzer applications follows. Again, this list is not intended to imply that these are the limits of Spectrum Analyzer applications.

Fluid movement tests on such diverse fluids as aerosol sprays and blood flow.

Line breakdown in high voltage power transmission is checked by monitoring noise on the power lines.

Checking the transmission fidelity of control signals transmitted by ordinary telephone lines.

Operating noise, vibration and resonances in gyro systems, motors, aircraft in flight, vibrating beams, and other machines and structures.

Temperature control in field emission cathode by monitoring the output signal.

Determine extent and location of flaws in various materials by ultrasonic pulsing and detecting the results with an S[illegible]

Determine harmonic and overtone properties of mus[illegible]al instruments.

Pulsed laser adjustment by tuning mirror system for maximum SA indication.

Speech research using recorder "tape loop" techniques.

Checking transmission properties of long (many miles) lines by sending variable frequency signal down the line and checking result with SA.

Classroom tool for teaching modulation, Fourier theory and signal synthesis.

TV Camera signal monitoring.

Nuclear magetic spin resonance tests.

Radio telescope output monitoring.

Holography work.

Biological studies by molecular absorption of microwave energy.

Monitor microwave oven in commercial drying operation.

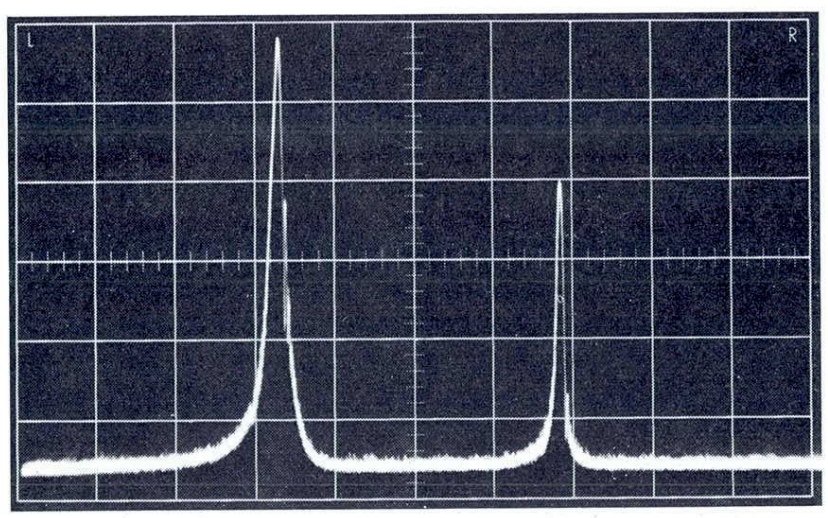
Magnetron production testing.

Frequency synthesizer testing.

Land mapping by placing beacons, which are then located (relative to each other) by analyzer flown in helicopter.

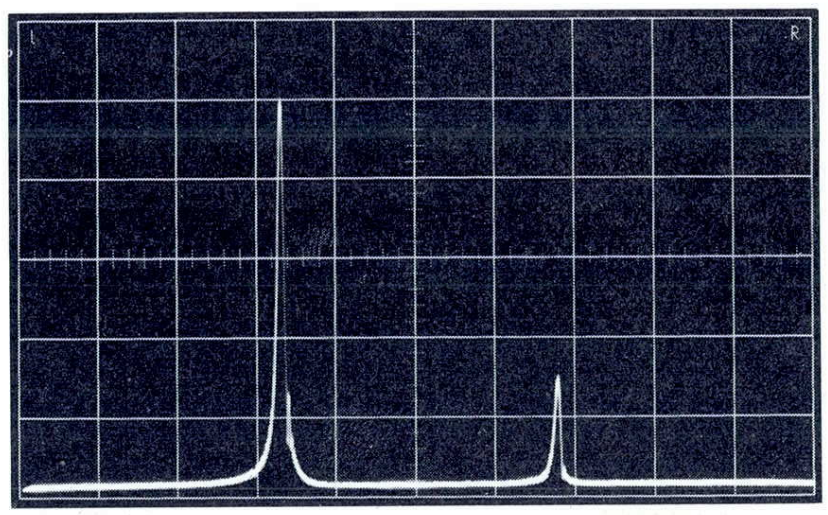
Two recent Spectrum Analyzer publications by Tektronix are now available. One contains useful application information, and the other discusses typical spectrum analyzer circuits. These are **Spectrum Analyzer Measurements** (PN 062-1070-00) and **Spectrum Analyzer Circuits** (PN 062-1055-00).

Perhaps you have been considering spectrum analysis as a possible solution for a measurement or test problem. Sho[illegible]d you have questions about any application, you are encoura[illegible] to discuss them with your Tektronix Field Engineer or Distributor.

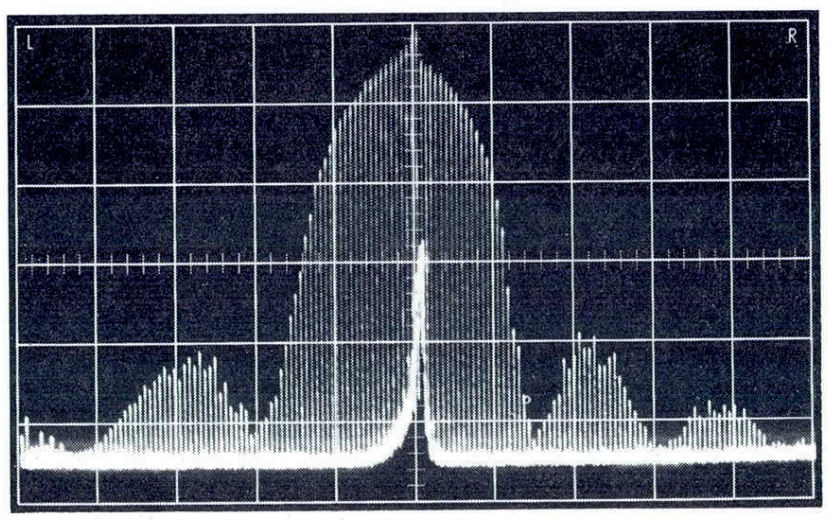


Log Detection Mode

500-Hz Modulation of 450-MHz Signal

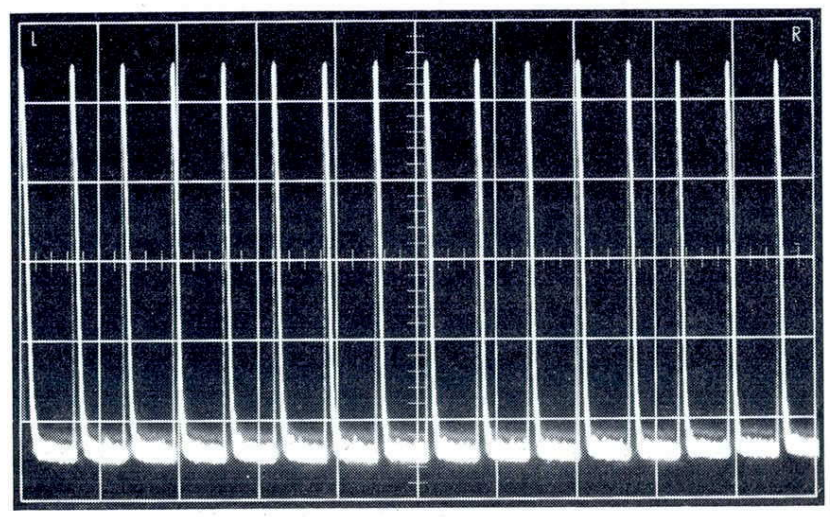


Linear Detection Mode



Repetition-Rate lines evident at 5 ms/cm
(Note: CW Feedthrough)

200-MHz Pulsed RF



Repetition-Rate measurement at 0.5 ms/cm
Zero Dispersion

Spectrum Analyzer Reference & Contents

GLOSSARY OF SPECTRUM ANALYZER TERMS

center frequency (radio frequency or intermediate frequency)—That frequency which corresponds to the center of the reference coordinate.

center frequency range (radio frequency)—That range of frequencies that can be displayed at the center of the reference coordinate. When referred to a control the term indicates the amount of frequency change available with the control.

display flatness—Uniformity of amplitude response over the rated maximum dispersion (usually in units of dB).

drift (frequency drift) (stability)—Long term frequency changes or instabilities caused by a frequency change in the spectrum analyzer local oscillators. Drift limits the time interval that a spectrum analyzer can be used without retuning or resetting the front panel controls (units may be Hz/s, Hz/°C, etc).

dynamic range (on screen)—The maximum ratio of signal amplitudes that can be simultaneously observed within the graticule (usually in units of dB).

dynamic range, maximum useful—The ratio between the maximum input power and the spectrum analyzer sensitivity (usually in units of dB).

frequency band—A range of frequencies that can be covered without switching.

Incremental linearity—A term used to describe local aberrations seen as non-linearities for narrow dispersions.

linear display—A display in which the vertical deflection is a linear function of the input signal voltage.

linearity (dispersion linearity)—Measure of the comparison of frequency across the dispersion to a straight line frequency change. Measured by displaying a quantity of equally spaced (in frequency) frequency markers across the dispersion and observing the positional deviation of the markers from an idealized sweep as measured against a linear graticule.

maximum input power—The upper level of input power that the spectrum analyzer can accommodate without degradation in performance (spurious responses and signal compression). (Usually in units of dBm).

minimum usable dispersion—The narrowest dispersion obtainable for meaningful analysis. Defined as ten times the incidental frequency modulation when limited by "incidental frequency modulation" (in units of Hz).

optimum resolution—The best resolution obtainable for a given dispersion and a given sweep time and theoretically (in units of Hz): optimum resolution =

$$\frac{\text{dispersion (in Hz)}}{\text{sweep time (in seconds)}}$$

phase lock—The synchronization of the local oscillator with a stable reference frequency.

resolution—The ability of the spectrum analyzer to display adjacent signal frequencies discretely. The measure of resolution is the frequency separation of two equal amplitude signals, the displays of which merge at the 3 dB down points (in units of Hz).

The resolution of a given display depends on three factors; sweep time, dispersion and the bandwidth of the most selective amplifier. The 6 dB bandwidth of the most selective amplifier (when Gaussian) is called resolution bandwidth and is the narrowest bandwidth that can be displayed as dispersion and sweep time are varied. At very long sweep times, resolution and resolution bandwidth are synonymous.

sensitivity—Rating factor of spectrum analyzers ability to display signals.

1. Signal equals noise. That input signal level (usually in dBm) which results in a display where the signal level above the residual noise is equal to the residual noise level above the baseline; expressed as: signal + noise = twice noise.

2. Minimum discernible signal. That input level (usually in dBm) which results in a display where the signal is just distinguishable from the noise.

skirt selectivity—A measure of the resolution capability of the spectrum analyzer when displaying signals of unequal amplitude. A unit of measure would be the bandwidth at some level below the 6 dB down points.

spurious response (spurii, spur)—A characteristic of a spectrum analyzer wherein displays appear which do not conform to the calibration of the radio frequency dial. Spurious responses are of the following type:

A. Intermediate frequency feedthrough. Wherein signals within the intermediate frequency passband of the spectrum analyzer reach the intermediate frequency amplifier and produce displays on the cathode-ray tube that are not tunable with the RF center frequency controls. These signals do not enter into a conversion process in the first mixer and are not affected by the first local oscillator frequency.

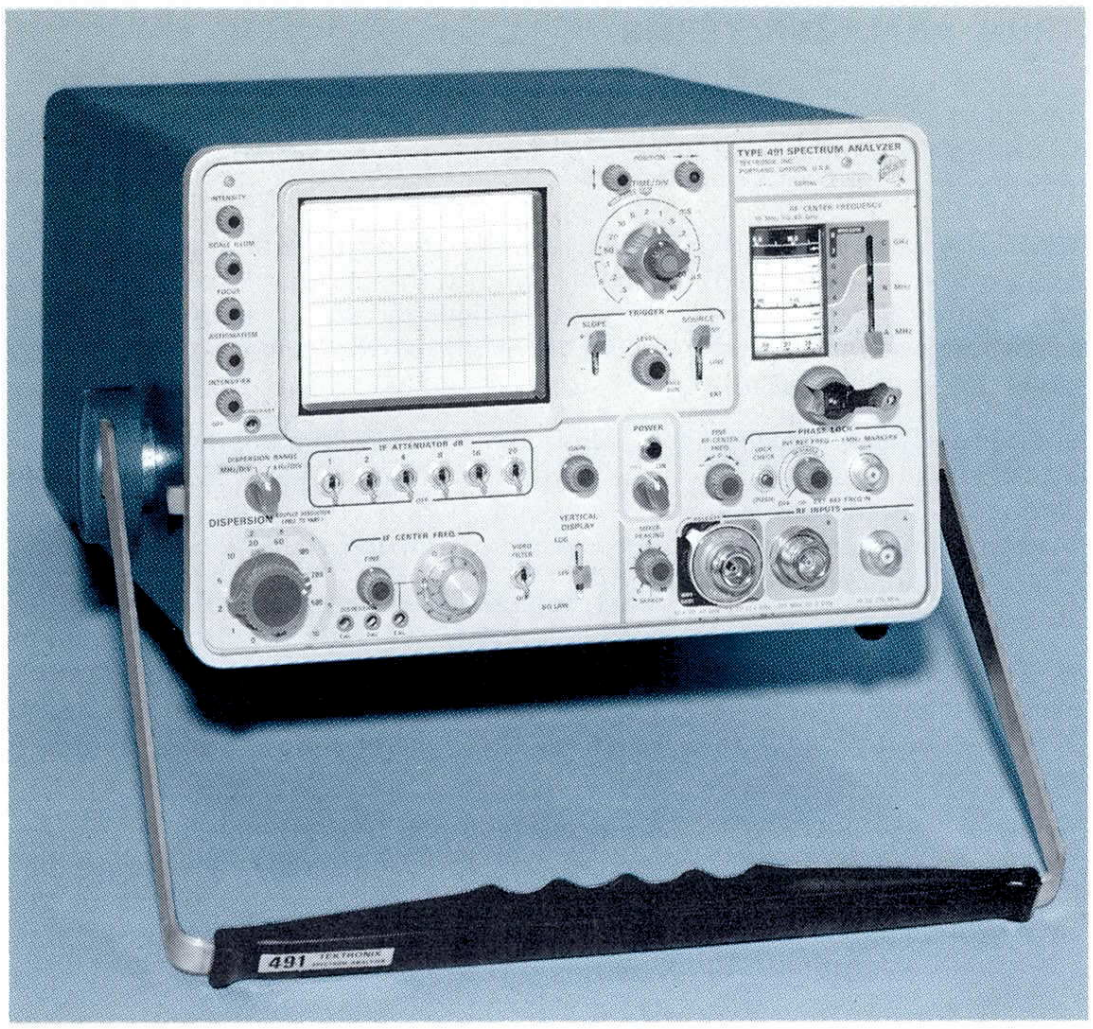
B. Image response. The superheterodyne process results in two major responses separated from each other by twice the intermediate frequency. The spectrum analyzer is usually calibrated for only one of these responses. The other is called the image.

INSTRUMENT	CHARACTERISTICS				
	CENTER FREQUENCY	CALIBRATED DISPERSION	COUPLED RESOLUTION[1]	INCIDENTAL FM	PRICE
1L5 3L5	50 Hz to 1 MHz	10 Hz to 100 kHz/div (100 Hz to 1 MHz full scale).	≤10 Hz to ≥500 Hz	≤3 Hz from 50 to 9900 Hz ≤10 kHz from 9.9 to 990 kHz	$1025 $1125
1L10 3L10	1 MHz to 36 MHz	10 Hz/div to 2 kHz/ div (100 Hz to 20 kHz full scale).	10 Hz to 1 kHz	IF—5 Hz LO—26 Hz to 61 Hz	$1175 $1275
1L20	10 MHz to 4.2 GHz	1 kHz/div to 10 MHz/div (10 kHz to 100 MHz full scale—CF ≥275 MHz).	1 kHz to 100 kHz	<300 Hz at fundamental, with phase lock	$1950
1L40	1.5 GHz to 40 GHz[2]				$2150
491	10 MHz to 40 GHz	1 kHz/div to 10 MHz/div (10 kHz to 100 MHz full scale—CF ≥275 MHz).	1 kHz to 100 kHz	<300 Hz at fundamental, with phase lock	$4895
491 MOD 139L	10 MHz to 2000 MHz				$3500
491 MOD 139M	1.5 GHz to 40 GHz[2]				$3700

1. The Resolution Control is coupled with the Calibrated Dispersion positions and separately switchable.
2. With optional accessories.

NOTE: The 1-Series Analyzers are used with the 530, 540, 550, and (using a Type 81A Adapter) 580-Series Oscilloscopes.
The 3-Series Analyzers are used with the 560-Series Oscilloscopes.
The 491 and the MOD 139L and MOD 139M are self-contained portables, also available for rackmounting.

491 10 MHz-to-40 GHz Spectrum Analyzer R491



- *COMPACT, LIGHT WEIGHT*
- *INTERNAL PHASE LOCK*
- *CALIBRATED DISPERSION TO 100 MHz*
- *COUPLED RESOLUTION*
- *WIDE-RANGE TIME BASE*
- *LOW POWER CONSUMPTION*
- *ENVIRONMENTALIZED*
- *SOLID-STATE DESIGN*

The Type 491 is a precision, wide-band spectrum analyzer designed for rugged environmental conditions and easy mobility. It is an easy-to-carry package weighing less than 40 pounds complete with accessories. The Type R491 is electrically identical, requires only 7 inches of rack height.

Operation is simple. Resolution and calibrated dispersion controls are coupled, providing narrow resolution bandwidth at narrow dispersion and wide resolution bandwidth at wide dispersion. Since dispersion is calibrated, frequency differences can be read directly from the CRT. Internal phase lock provides stable displays even at 1 kHz/div dispersion.

Two modified instruments are available for applications which do not require the full center frequency range (10 MHz to 40 GHz) of the Type 491. These are the 491 MOD 139L (10 MHz to 2000 MHz) and the 491 MOD 139M (1.5 GHz to 40 GHz). Specifications for the MOD 139L and MOD 139M are the same as for the 491 except where noted.

Each instrument is completely self contained, has oscilloscope-type time base and trigger circuits, 8 x 10-div CRT with P7 phosphor and internal graticule. They operate over a wide range of AC voltages, require only 55 W, maximum.

BAND	FREQUENCY RANGE	MINIMUM CW SENSITIVITY*	
		1-kHz RESOLUTION	100-kHz RESOLUTION
1	10 MHz to 275 MHz	≥ —100 dBm	≥ —80 dBm
2	275 MHz to 900 MHz	≥ —110 dBm	≥ —90 dBm
3	800 MHz to 2000 MHz	≥ —105 dBm	≥ —85 dBm
4	1.5 GHz to 4.0 GHz	≥ —110 dBm	≥ —90 dBm
5	3.8 GHz to 8.2 GHz	≥ —100 dBm	≥ —80 dBm
6	8.2 GHz to 12.4 GHz	≥ —95 dBm	≥ —75 dBm
7	12.4 GHz to 18.0 GHz	≥ —90 dBm	≥ —70 dBm
8	18.0 GHz to 40 GHz	≥ —80 dBm to 26.5 GHz ≥ —70 dBm to 40 GHz	≥ —60 dBm ≥ —50 dBm

*Signal + noise = 2 X noise

Bands 1-8 are covered in the Type 491.

Bands 1-3 only are available in 491 MOD 139L.

Bands 4-8 only are available in 491 MOD 139M, bands 4-6 directly, bands 7-8 using optional accessories.

CHARACTERISTICS

DIAL ACCURACY

± (2 MHz + 1% of dial reading).

CALIBRATED DISPERSION

1 kHz/div to 10 MHz/div in 1-2-5 sequence, 2 ranges (kHz/div —MHz/div). Accuracy throughout full range of RF-center frequency control, within ±3% except at 2 MHz/div (±5%) and 1 MHz/div (±7%). Accuracy can be increased using internal 1-MHz crystal markers for calibration. Dispersion linearity within ±3%. Zero dispersion useful for PRF measurements.

COUPLED RESOLUTION

1 kHz to 100 kHz, coupled with calibrated dispersion positions but separately switchable.

491 10 MHz-to-40 GHz Spectrum Analyzer R491

DISPLAY FLATNESS
Maximum amplitude variation over 100-MHz dispersions up to 12.4 GHz is 3-dB or less, except over 50-MHz dispersion in Band 1. Above 12.4 GHz the maximum amplitude variation (100-MHz dispersion) is 6-dB or less.

INCIDENTAL FM
Less than 300 Hz at fundamental, with Phase Lock.

FREQUENCY STABILITY
kHz/div dispersion range—±10 kHz throughout line voltage range after 1 minute; ±5 kHz/°C. MHz/div dispersion range—±200 kHz throughout line voltage range after 1 minute; ±20 kHz/°C.

PHASE LOCK
Internal 1-MHz reference. External input accepts 1-MHz to 5-MHz signals from 1 V to 5 V peak to peak.

INPUT IMPEDANCE
Approx 50 Ω for coaxial inputs.

MAXIMUM INPUT POWER
—30 dBm for linear operation, +15 dBm (25 mW) safe diode power limit.

IF ATTENUATOR
51 dB in 1-dB steps, ±0.1 dB/dB.

IF GAIN CONTROL
>50-dB range.

IF CENTER FREQUENCY
±25-MHz adjustment of center frequency from 5 MHz/div to 0.2 MHz/div dispersion positions, ±10-MHz adjustment at 10 MHz/div, ±2.5-MHz adjustment from 500 kHz/div to 1 kHz/div dispersion positions.

VERTICAL DISPLAY (8 DIVISIONS)
Log — ≥40-dB dynamic range.
Linear — ≥26-dB dynamic range.
Square Law — ≥13-dB dynamic range.

HORIZONTAL DEFLECTION

INTERNAL SAWTOOTH GENERATOR
10 μs/div to 0.5 s/div in 15 calibrated steps (1-2-5 sequence). Uncalibrated continuously variable between steps and to approx 1.25 s/div.

TRIGGER SOURCE
Internal, external, or line. 100-V maximum external input (DC + peak AC).

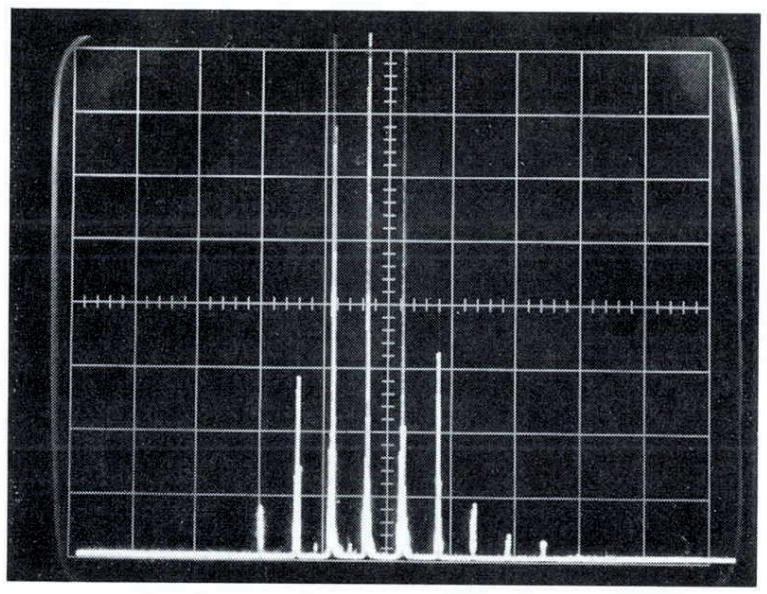
TRIGGER REQUIREMENTS
0.2-div deflection or 0.2-V external from 20 Hz to 100 kHz.

CRT AND DISPLAY FEATURES

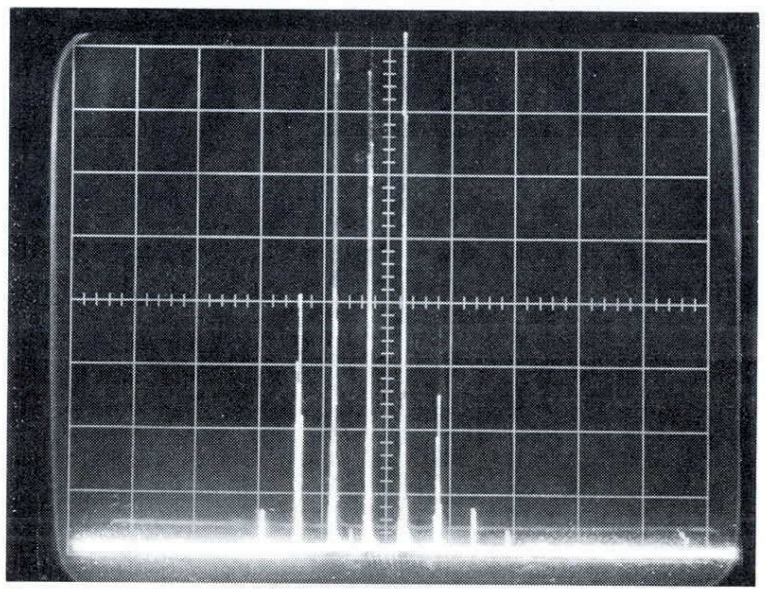
TEKTRONIX CRT
8 x 10-div display area (each div = 0.8 cm); P7 phosphor.

GRATICULE
Internal, no parallax, variable edge lighting.

DISPLAY FEATURES
Intensity, focus and astigmatism controls. Intensifier adjusts relative brightness of signal and baseline for convenient viewing and photography.



Quality of photographs is greatly enhanced when relative brightness of signal and baseline can be controlled, as in upper waveform. Lower waveform taken under same conditions shows normal results of slow sweep time/div settings. Improvement is even more pronounced in some applications. Waveforms photographed with C-30A Camera.



ENVIRONMENTAL CAPABILITIES

ELECTROMAGNETIC INTERFERENCE
Meets specifications of MIL-I-6181D over the following frequency ranges: Radiated (with CRT mesh filter installed) —150 kHz to 1 GHz; conducted (power line) —150 kHz to 25 MHz.

TEMPERATURE
Operating: —15° C to +55° C.
Non-operating: —55° C to +75° C.

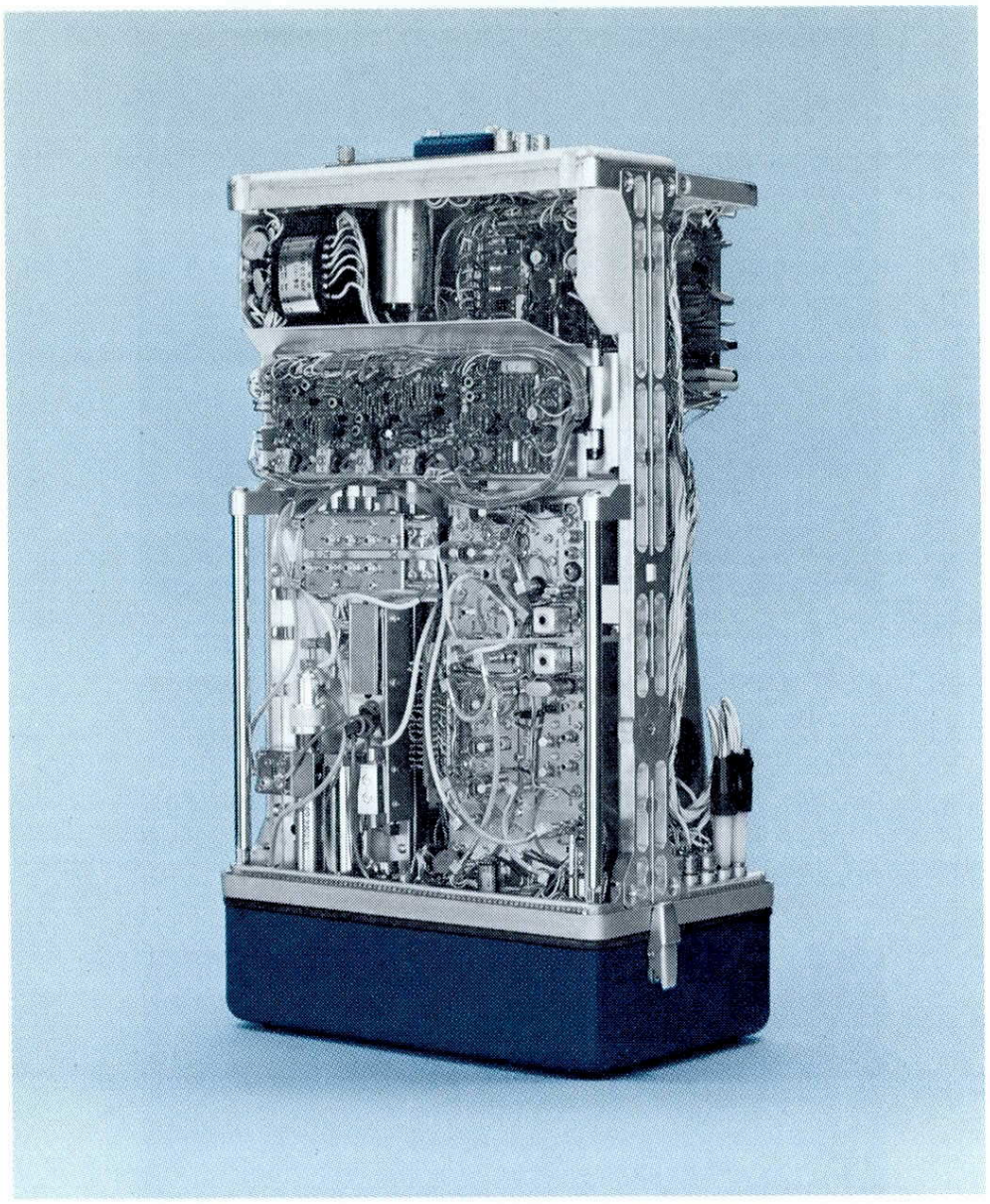
ALTITUDE
Operating: 15,000 feet.
Non-operating: 50,000 feet.

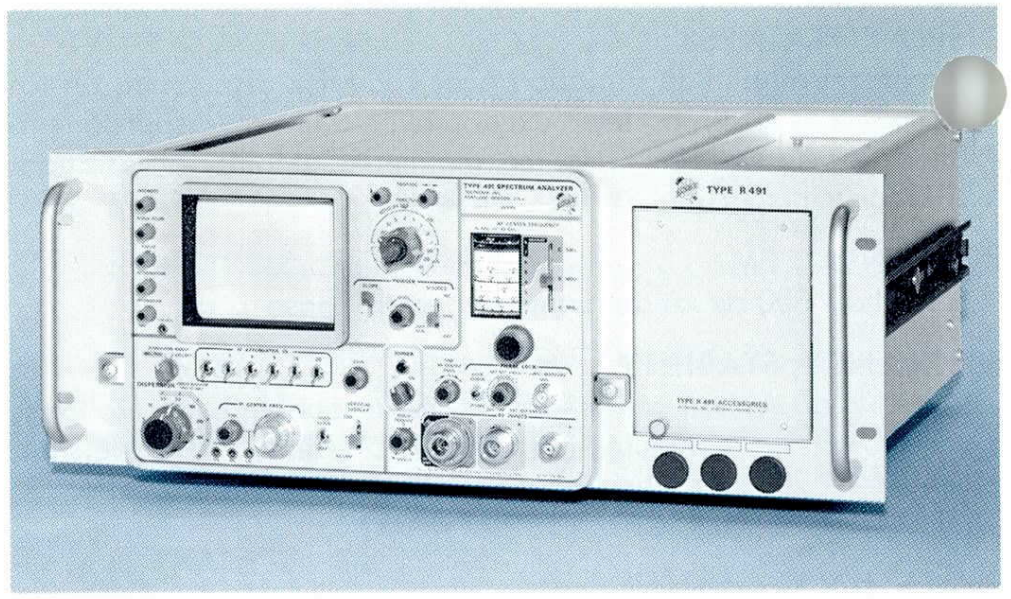
HUMIDITY
Non-operating: Meets electrical performance specifications after exposure to five cycles (120 hours) of Mil-Std-202C, Method 106B (omit freezing and vibration, and allow a 24-hour post-test drying period at +25° C and 20% to 80% relative humidity).

VIBRATION
Operating: 15 minutes along each of the three axes, 0.025 inch peak to peak displacement (4 g's at 55 c/s) 10 to 55 to 10 c/s in 1-minute cycles.

SHOCK
Operating and non-operating: 30 g's, ½ sine, 11-ms duration, 1 shock per axis.

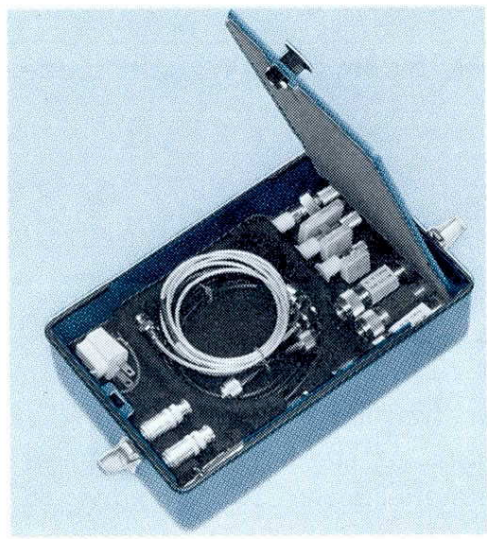
10 MHz-to-40 GHz Spectrum Analyzer

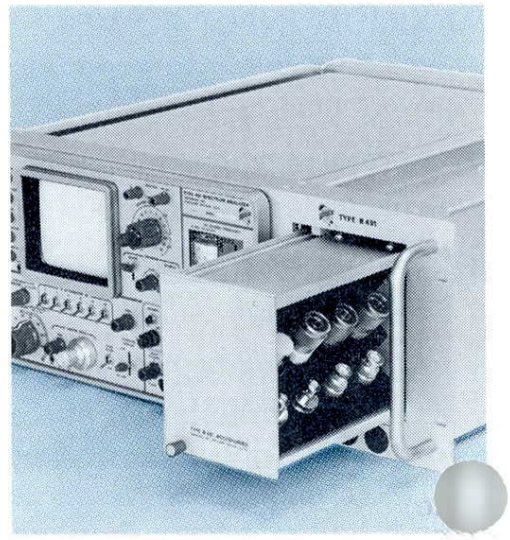




RACKMOUNTING

Type R491 withdraws from rack on slide-out tracks, tilts for convenience. Further mounting information on catalog instrument dimension page.





ACCESSORY STORAGE

Included panel cover for Type 491 and drawer for Type R491 hold all standard accessories except manuals and dust and rain cover.

INCLUDED STANDARD ACCESSORIES

6 ft BNC cable, 50 Ω miniature coax (012-0113-00); 6 ft N cable, RG 223/U coax (012-0114-00); 2 ft TNC cable, RG 223/U coax (012-0115-00); wave guide mixer, 12.4 to 18 GHz (119-0097-00); wave guide mixer, 18 to 26.5 GHz (119-0098-00); wave guide mixer, 26.5 to 40 GHz (119-0099-00); 10-dB attenuator, Type N fittings (011-0085-00); 20-dB attenuator, Type N fittings (011-0086-00); 40-dB attenuator, Type N fittings (011-0087-00); two BNC male to N female adapters (103-0058-00); two BNC female to N male adapters (103-0045-00); wave guide mixer adapter (119-0104-00); power cord (161-0024-03); oscilloscope dust and rain cover (016-0074-01); 3 to 2-wire adapter (103-0013-00); blue light filter (378-0558-00); amber light filter (378-0559-00); clear CRT protector plate (386-0118-00); ornamental ring (354-0248-00); mesh filter, installed (378-0571-00); two one-ampere fuses (159-0022-00); ½-ampere fuse (159-0025-00); front cover (200-0633-03); two instruction manuals (070-0598-01). Type R491 includes all above accessories except the panel and oscilloscope cover, also includes mounting tracks and hardware.

TYPE 491 SPECTRUM ANALYZER **$4895**

TYPE R491 SPECTRUM ANALYZER **$4995**

OTHER CHARACTERISTICS

POWER REQUIREMENTS

90 to 136 VAC or 180 to 272 VAC, 48 to 440 Hz; 55 watts maximum. Rear panel selector provides rapid accommodation for six line-voltage ranges.

REAR PANEL CONNECTORS

BNC connectors for external trigger input, sawtooth output (70 to 90 mV P to P) and recorder output (≥4 mV/div of displayed signal in LIN mode, DC-coupled, approx 600-Ω source resistance).

CABINET MODEL DIMENSIONS AND WEIGHTS

Height	$7\frac{3}{16}$ in	18.2 cm
Width	$12\frac{7}{16}$ in	31.6 cm
Depth (incl. panel cover)	$19\frac{11}{16}$ in	50.0 cm
Depth (with handle extended)	$21\frac{9}{16}$ in	54.7 cm
Net weight (w/o panel cover)	30 lb	13.6 kg
Weight (with panel cover and accessories)	38 lb	17.3 kg
Domestic shipping weight	≈50 lb	≈22.7 kg
Export-packed weight	≈62 lb	≈28.2 kg

RACK MODEL DIMENSIONS AND WEIGHTS

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Rack depth	$17\frac{1}{2}$ in	44.4 cm
Net weight	41 lb	18.6 kg
Domestic shipping weight	≈72 lb	≈32.7 kg

10 MHz-to-40 GHz Spectrum Analyzer

TYPE 491 MOD 139L

10 MHz to 2000 MHz Spectrum Analyzer

The Type 491 MOD 139L has a center frequency range of 10 MHz to 2000 MHz. The chart on the first page defines the Frequency Range and Minimum CW Sensitivity (S + N = 2N) of the MOD 139L. The appearance is the same as that of the Type 491 with the following exceptions: the C-band input is removed and the center frequency range dial is changed to reflect the reduction in the number of frequency bands.

INCLUDED STANDARD ACCESSORIES (491 MOD 139L ONLY)

6-ft BNC cable, 50-Ω miniature coax (012-0113-00); 6-ft N cable, RG 223/U coax (012-0114-00); power cord (161-0024-03); 3 to 2-wire adapter (103-0013-00); oscilloscope dust and rain cover (016-0074-01); blue light filter (378-0558-00); amber light filter (378-0559-00); two 1-ampere fuses (159-0022-00); ½-ampere fuse (159-0025-00); front cover (200-0633-03); ornamental ring (354-0248-00); clear CRT protector plate (386-0118-00); and two special instruction manuals.

The R491 MOD 139L also includes rackmounting track (351-0101-00) and hardware (016-0096-00). The front cover and rain cover are deleted.

TYPE 491 MOD 139L $3500
TYPE R491 MOD 139L $3600

TYPE 491 MOD 139M

1.5 GHz to 12.4 GHz Spectrum Analyzer (40 GHz with Optional Accessories)

The Type 491 MOD 139M has a center frequency range of 1.5 GHz to 40 GHz with optional accessories. The chart on the first page defines the Frequency Range and Minimum CW Sensitivity (S + N = 2N). The appearance is the same as that of the Type 491 with the following exceptions: the A and B band inputs are removed and the center frequency range dial is changed to reflect the reduction in the number of frequency bands.

INCLUDED STANDARD ACCESSORIES (491 MOD 139M ONLY)

6-ft N cable, RG 223/U coax (012-0114-00); power cord (161-0024-03); 3 to 2-wire adapter (103-0013-00); oscilloscope dust and rain cover (016-0074-01); blue light filter (378-0558-00); amber light filter (378-0559-00); two 1-ampere fuses (159-0022-00); ½-ampere fuse (159-0025-00); front cover (200-0633-03); ornamental ring (354-0248-00); clear CRT protector plate (386-0118-00); and two special instruction manuals.

The R491 MOD 139M also includes rackmounting track (351-0101-00) and hardware (016-0096-00). The front cover and rain cover are deleted.

TYPE 491 MOD 139M $3700
TYPE R491 MOD 139M $3800

OPTIONAL ACCESSORIES FOR THE 491 MOD 139L AND 491 MOD 139M

BNC male to N female adapter (103-0058-00) ..... $ 2.40
BNC female to N male adapter (103-0045-00) ..... $ 2.40
10-dB attenuator, Type N fittings (011-0085-00) $45.00
20-dB attenuator, Type N fittings (011-0086-00) $45.00
40-dB attenuator, Type N fittings (011-0087-00) $55.00

OPTIONAL ACCESSORIES FOR THE 491 MOD 139M

NOTE: These accessories are required to extend the requency range of the MOD 139M from 12.4 GHz to 40 GHz.

Cable, TNC, coaxial, 2 feet (012-0115-00) ..... $ 9.20
Waveguide mixer adapter (119-0104-00) ..... $ 44.00
Waveguide mixer 12.4-18.0 GHz (119-0097-00) ..... $ 77.00
Waveguide mixer 18.0-26.5 GHz (119-0098-00) ..... $ 88.00
Waveguide mixer 26.5-40.0 GHz (119-0099-00) $138.00

CONVERSION KITS

PORTABLE TO RACK-MODEL

Kit includes hardware and instructions to convert Type 491 Analyzers for rack installations.
Order 040-0444-00 ..... $138

RACK MODEL TO PORTABLE

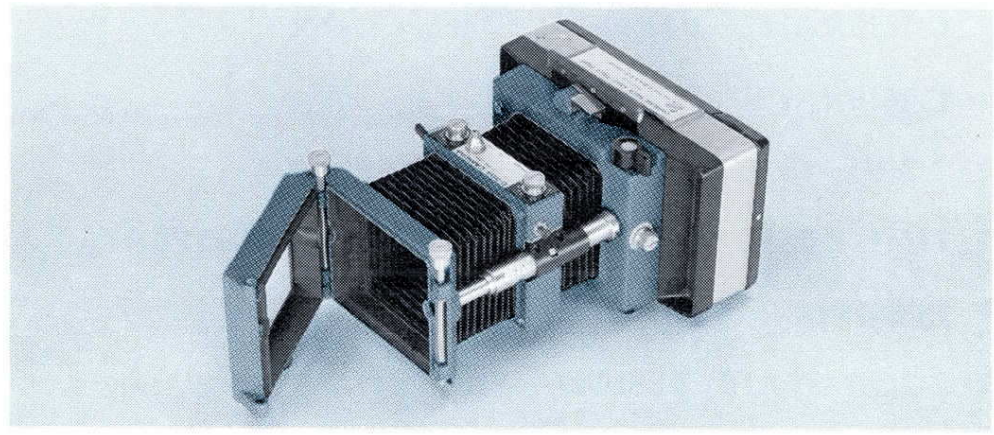
Kit includes cabinet, panel cover, oscilloscope cover, and instructions to convert Type R491 Analyzers for portable operation.
Order 040-0445-00 ..... $85

OPTIONAL ACCESSORIES

The following accessories are usable on the 491, 491 MOD 139L, 491 MOD 139M and their rackmount configurations. Cameras, Scope-Mobile® Carts and other major accessories are completely described in the catalog accessory pages.

COLLAPSIBLE VIEWING HOOD

Permits viewing of trace under high ambient-light conditions.
Order 016-0082-00 ..... $9.00



C-30A CAMERA

f/1.9 lens; magnification variable from 1.5:1 to 0.7:1; Polaroid Land* Pack-Film back, order C-30A-P $480

SCOPE-MOBILE® CART

Model 200-1 friction lock holds Type 491 at 0° to 60° angle. Cart occupies <18 inches of aisle space, carries up and down stairs easily, has storage space in base. A more complete description with photographs is given in the General Accessories Section.
Order 200-1 ..... $95.00

PANEL COVER

Included as a part of Type 491, protects front panel and holds standard accessories. Available separately for use with Type R491, order 200-0633-03 ..... $20.00

BNC THRU-PANEL ADAPTER

Mounts in pre-punched holes in Type R491 panel, BNC connector on both sides, order 103-0070-00 ..... $2.50

BNC CABLE

Used in conjunction with above adapter, provides access to rear-panel connectors on Type R491. BNC-to-BNC 30-in cable, order 012-0117-00 ..... $6.90

*Registered Trademark, Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

1L5 50 Hz-to-1 MHz Spectrum Analyzer 3L5

- ***CALIBRATED VERTICAL DEFLECTION***
- ***CALIBRATED DISPERSION***
- ***10 Hz to 1 MHz IN ONE DISPLAY***
- ***TIME-BASED OR FREQUENCY-BASED DISPLAYS***
- ***RECORDER OUTPUT***
- ***SOLID-STATE DESIGN***

The Type 1L5 and 3L5 operate over a center-frequency range of 50 Hz to 1 MHz, and provide accurate spectral and time-based displays from 10 Hz to 1 MHz. Calibrated volts/cm and Hz/cm controls make the Type 1L5 and 3L5 as easy to use as the oscilloscope in which each is operated. The 1L5 operates in the Type 530, 540, 550, or (with adapter) 580-Series Oscilloscopes. The Type 3L5 operates in the Type 561B or 564B (and the earlier 561A and 564) Oscilloscopes in combination with a Type 2B67, 3B3, 3B4, or 3B5 Time-Base Unit.*

Resolution bandwidth extends from 10 Hz to 500 Hz. High-resolution spectral displays can be viewed in their entirety (even at the very slow sweep rates required for maximum resolution) with the Type 549 Storage Oscilloscope. Stored displays can also be compared with subsequent displays, and can be easily photographed for permanent record.

Applications include vibration studies, waveform analysis, and noise measurements. Others are listed in the reference section.

*IMPORTANT: Time Base Units with serial numbers under those listed require a simple modification to provide a sweep signal to the Analyzer. Type 2B67: 15180, Type 3B3: 4270, Type 3B4: 740. Modification Kit part number 040-0413-00.

SPECTRAL DISPLAYS

CENTER FREQUENCY RANGE

50-Hz to 990-kHz, calibrated in 10-Hz, 100-Hz, 1-kHz 10-kHz steps. Continuously variable to at least 1 MHz.

CENTER FREQUENCY	ACCURACY
50 Hz to 990 Hz	±(5% + 50 Hz + 50 Hz/°C change)
1000 Hz to 9900 Hz	±(5% + 100 Hz + 100 Hz/°C change)
10 kHz to 99 kHz	±(5% + 3 kHz + 200 Hz/°C change)
100 kHz to 990 kHz	±(5% + 10 kHz + 200 Hz/°C change)

STABILITY

50 Hz to 9900 Hz — 100 Hz/hour or less with stable ambient temperature (±1°C).

DEFLECTION FACTOR

10 μV/cm to 2 V/cm, calibrated in RMS volt/cm (1-2-5 sequence). Accurate within 3% from 1 mV/cm to 2 V/cm, within 6% from 10 μV/cm to 500 μV/cm (÷100 pulled), for linear displays at maximum resolution. The uncalibrated variable control is continuous between steps (≈3:1).

CALIBRATED DISPERSION

10 Hz/cm to 100 kHz/cm in 9 steps. Accuracy at center frequencies of:

a) 50 Hz to 9900 Hz — ≤±10% (20°C to 30°C)
— ≤±20% (0°C to 50°C)
b) 10 kHz to 990 kHz — ≤15% (0°C to 50°C)

Linearity is within 3%.

COUPLED RESOLUTION

≤10 Hz to ≥500 Hz (20°C to 30°C), coupled with the dispersion control but separately switchable.

DISPLAY FLATNESS

Amplitude variations are within 0.5 dB from 10 Hz to 1 [illegible] at most deflection factors; except within +0.5 dB, —3 dB at 1 mV/cm and 2 mV/cm (or 10 μV/cm and 20 μV/cm with ÷100 pulled).

50 Hz-to-1 MHz Spectrum Analyzer

NOISE
5 μV RMS.

DYNAMIC RANGE
$\geq$60 dB in LOG (uncalibrated) mode.

INTERMODULATION DISTORTION AND SPURIOUS SIGNALS
(1L5) $\geq$50 dB below the 6-cm signal level.
(3L5) $\geq$50 dB below the 8-cm signal level.

RECORDER OUTPUT
5 to 15 mV for 6-cm display, into 600-Ω.

LOCAL OSCILLATOR OUTPUT
Must sweep $\geq$1 MHz from $\approx$3 MHz to $\approx$2 MHz; $\geq$1 V peak to peak.

1L5 SWEEP MODES
Manual, internal and external. Accuracy of frequency measurements can be increased using manual scan and monitoring the local oscillator output with a frequency counter. Type 549 Storage Oscilloscope and Type 556 Dual-Beam Oscilloscope provides an internally-coupled sweep to the Analyzer; external input is used with other oscilloscopes.

3L5 SWEEP MODES
Manual and internal. Accuracy of frequency measurements can be increased using manual scan and monitoring the local oscillator output with a frequency counter. Type 561B and 564B Oscilloscopes with time base unit provide an internally-coupled sweep to the Analyzer.

TIME-BASED DISPLAYS

BANDWIDTH
10 Hz to 1 MHz at most deflection factors; 10 Hz to 700 kHz at 0.1 V/cm and 0.2 V/cm (or 1 mV/cm and 2 mV/cm with $\div$100 switch pulled).

DEFLECTION FACTOR
1 mV/cm to 100 V/cm in calibrated P-to-P steps (1-2-5 sequence), accurate within 3% (within 6% from 5 V/cm to 100 V/cm). Uncalibrated control provides continuous variation between steps, reduces gain by a factor of approx 3.

INPUT
1 megohm paralleled by approx 30 pF.
300 V DC + peak AC maximum input voltage.

OTHER CHARACTERISTICS

1L5 WEIGHTS

Net weight	6 lb	2.7 kg
Domestic shipping weight	$\approx$10 lb	$\approx$4.5 kg
Export-packed weight	$\approx$18 lb	$\approx$8.2 kg

3L5 WEIGHTS

Net weight	5¾ lb	2.6 kg
Domestic shipping weight	$\approx$ 8 lb	$\approx$3.6 kg
Export-packed weight	$\approx$12 lb	$\approx$5.5 kg

INCLUDED STANDARD ACCESSORIES
1X probe (010-0193-00), banana-to-banana cable (012-0031-00), BNC-to-banana cable (012-0091-00), plug (134-0052-00), plug protector (134-0076-00), two instruction manuals (070-0600-01 for Type 1L5) or (070-0630-01 for Type 3L5).

TYPE 1L5 SPECTRUM ANALYZER UNIT $1025

TYPE 3L5 SPECTRUM ANALYZER UNIT $1125

OPTIONAL ACCESSORIES

The standard 1X probe supplied with the analyzer satisfies most measurement requirements. Optional probes may be better suited for particular applications. See catalog accessory pages for additional information on these and other items.

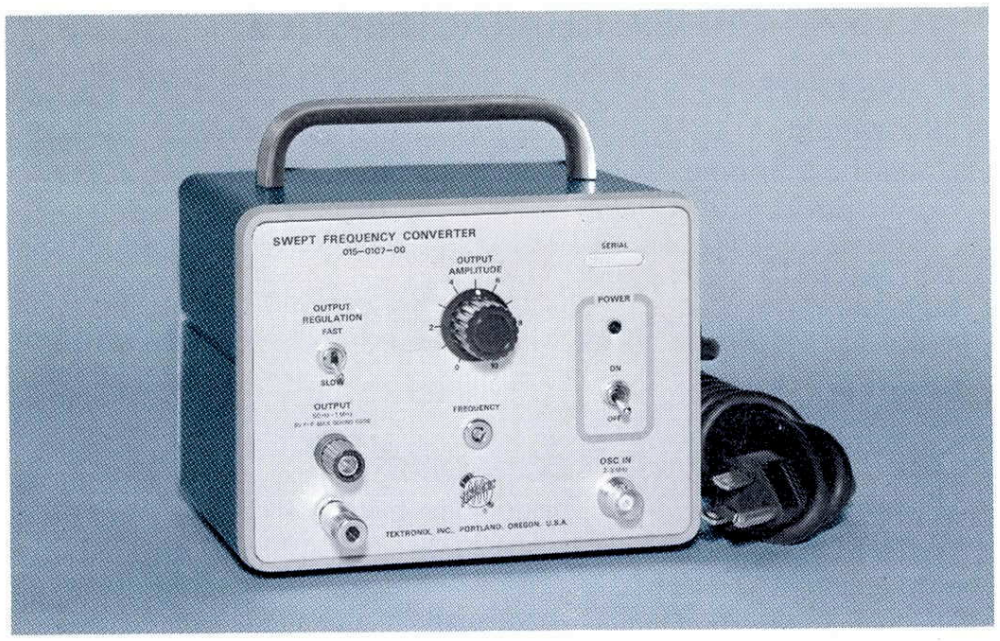
P6007 100X Probe Package, order 010-0150-00 . . . . . $29.00

P6012 10X Probe Package, order 010-0203-00 . . . . . $36.00

600-Ω Termination (BNC), order 011-0092-00 . . . . . $16.50

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Swept Frequency Converter



- ***SLAVED SPECTRUM ANALYZER-SWEPT FREQUENCY DISPLAYS***
- ***50-Hz to 1-MHz CENTER FREQUENCY***
- ***1-MHz DISPERSION CAPABILITY***
- ***OUTPUT CONSTANT WITHIN 0.5 dB***

The Swept Frequency Converter is designed as an accessory unit to the Type 3L5 and Type 1L5 Low Frequency Spectrum Analyzer Plug-In Units. It accepts the local oscillator output from the analyzer (approx 2 MHz to 3 MHz) and converts it to a signal source slaved to the center frequency and dispersion setting of the analyzer.

The result is a signal source with center frequency range of 50 Hz to 1 MHz, single frequency (analyzer in MANUAL SWEEP mode) or swept frequency with dispersion capability of 1 MHz max to 100 Hz min. It provides for variable amplitude control and regulation for constant output within 0.5 dB. Sweep rate is controlled by the horizontal TIME BASE which sweeps the local oscillator of the analyzer and, thereby, the converter.

CHARACTERISTICS

OUTPUT FREQUENCY—50 Hz to 1 MHz, selectable within the center frequency range of the Spectrum Analyzer.

OUTPUT VOLTAGE—4 V P-P to 8 V P-P max behind 600 Ω.

OUTPUT FREQUENCY FLATNESS—within 0.5 dB into 600 Ω.

OSCILLATOR INPUT VOLTAGE (from Spectrum Analyzer) 0.8 V P-P to 2 V P-P.

OUTPUT REGULATION

FAST—effective in preserving amplitude flatness when lowest frequency component is not less than 10 kHz and sweep rate is 10 ms/div or faster.

SLOW—used when frequency is less than 10 kHz and for sweep rates slower than 10 ms/div.

OUTPUT AMPLITUDE RECOVERY (output regulator FAST to SLOW)

10 s or less to recover to same amplitude as FAST.

OUTPUT RESISTANCE—600 Ω within 15%.

POWER REQUIREMENTS—90 VAC to 272 VAC, 50 Hz to 400 Hz.

DIMENSIONS AND WEIGHTS

Height	5½	in	14.0 cm
Width	5 13/16	in	14.7 cm
Depth	5¾	in	14.5 cm
Net weight	3½	lb	1.6 kg
Domestic shipping weight	≈7½	lb	≈ 3.4 kg
Export-packed weight	≈12	lb	≈ 5.5 kg

INCLUDED STANDARD ACCESSORIES

600-Ω termination (011-0092-00); two BNC cables (012-0075-00); 3- to 2-wire adapter (103-0013-00); BNC-to-dual banana adapter (103-0090-00); two instruction manuals (070-0762-00).

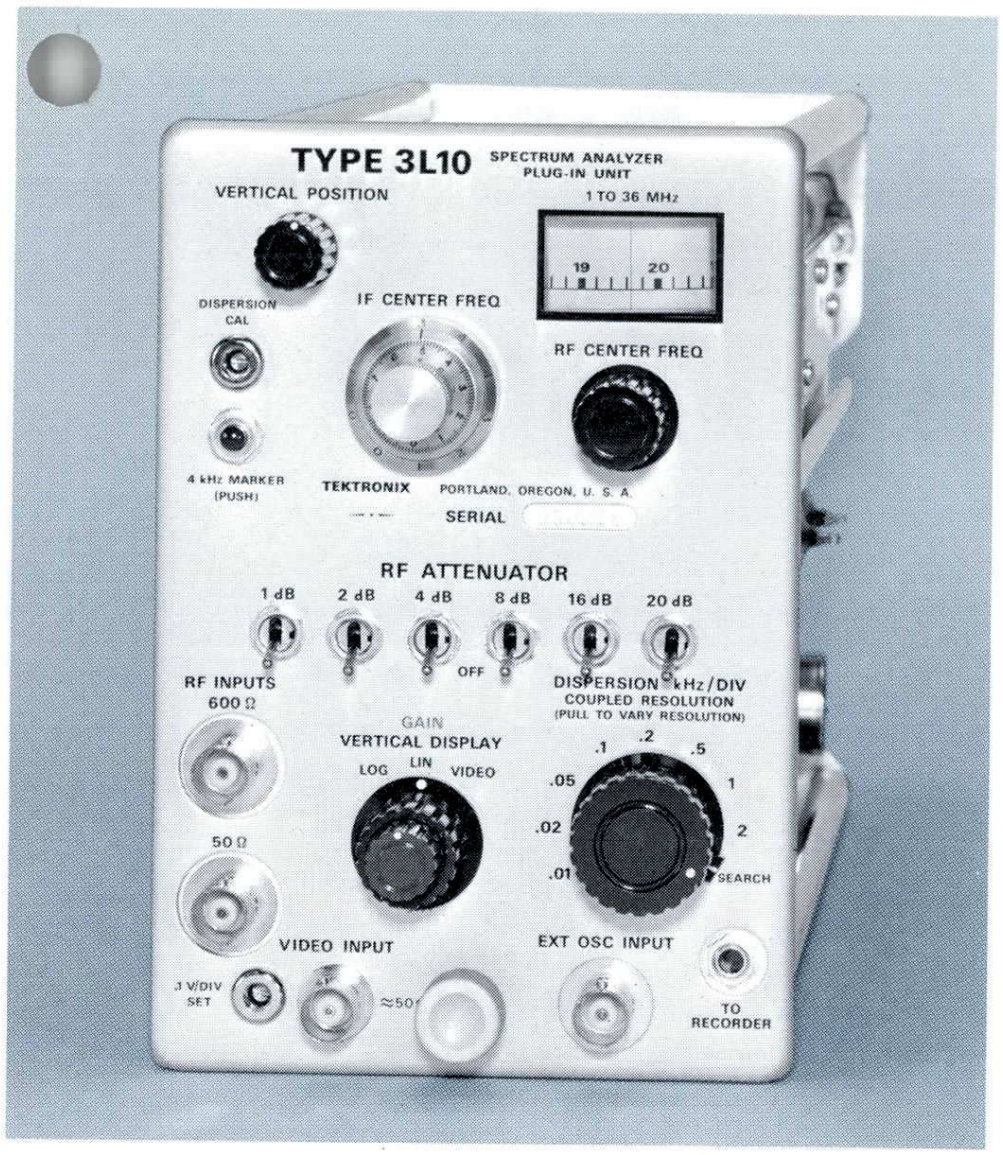
SWEPT FREQUENCY CONVERTER, order 015-0107-00 . . **$330**

600-Ω STEP ATTENUATOR

The 600-Ω Step Attenuator is a 0 to 51 dB switch attenuator for use with the Type 1L5. The input resistance is 600 Ω (within 2%). The attenuation error is 0.05 dB/dB of indicated attenuation. Power rating is ⅛ W max. Bandwidth is DC to 1 MHz.

600-Ω Step Attenuator (order 011-0093-00) $83

3L10 1 MHz-to-36 MHz Spectrum Analyzer 1L10



- ***CALIBRATED DISPERSION***
- ***COUPLED RESOLUTION***
- ***CRYSTAL-CONTROLLED SWEPT OSCILLATOR***
- ***IMAGE REJECTION***
- ***RECORDER OUTPUT***
- ***STORED SPECTRAL DISPLAYS***

The 1L10 1-to-36 MHz Analyzer provides low-cost spectrum analysis with the Type 530, 540, 550, or (with adapter) 580-Series Oscilloscope. The Type 549 Storage Oscilloscope adds further convenience to spectrum analysis.

The Type 3L10 Analyzer permits low-cost spectrum analysis with the compact Type 561B Oscilloscope, and stored or non-stored displays with the equally-compact Type 564B Oscilloscope. The Type 3L10 can be used with a Type 2B67, 3B3, 3B4 or 3B5 Time-Base Unit.*

The following specifications are common to the 1L10 and 3L10 except where noted.

CALIBRATED DISPERSION from 10 Hz/div to 2 kHz/div makes frequency measurement as easy and accurate as time measurement. Frequency differences can be read directly from the CRT. The SEARCH MODE permits rapid location of signals for analysis.

COUPLED RESOLUTION from 10 Hz to 1 kHz greatly simplifies operation, providing narrow resolution bandwidth at narrow dispersion and wide resolution bandwidth at wide dispersion. Dispersion and resolution controls can be uncoupled and operated separately if desired, for optimized viewing of a particular signal.

IF stability is achieved through use of CRYSTAL-CONTROLLED OSCILLATORS. Even the swept local oscillator is controlled through a crystal discriminator. An external front-end oscillator can be connected through a front-panel input to provide still greater stability to spectral displays within or outside the normal 1-to-36 MHz range of the Type 3L10.

IMAGE REJECTION is achieved through use of a 60-MHz first IF amplifier, which places images at more than twice the upper tuning frequency of the Type 3L10.

Analyzer familiarity is soon achieved, since operation is similar to that of the oscilloscope—with dispersion calibrated in kHz/div. Dispersion accuracy is quickly verified with crystal-controlled frequency markers available at the push of a button. This feature is especially convenient where the Analyzer is used with more than one oscilloscope.

FREQUENCY RANGE
1 to 36 MHz.

MINIMUM CW SENSITIVITY (50-Ω INPUT)
—100 dBm, measured at 2 kHz/div dispersion and 1 kHz (coupled) resolution.

DIAL ACCURACY
±(100 kHz + 1% of dial reading).

1L10 CALIBRATED DISPERSION
0.01 kHz/cm to 2 kHz/cm, 8 steps, 1-2-5 sequence. Accuracy within ±3% when adjusted for individual oscilloscope. Dispersion linearity within ±5%. Search position (uncalibrated) —minimum 20 kHz + 1 kHz/MHz dial frequency full scale (10 cm).

*IMPORTANT: Time-Base Units with serial numbers under those listed require a simple modification to provide a sweep signal to the Analyzer. Type 2B67: 15180, Type 3B3: 4270, Type 3B4: 740. Modification Kit part number 040-0413-00.

3L10 1 MHz-to-36 MHz Spectrum Analyzer 1L10

3L10 CALIBRATED DISPERSION
10 Hz/div to 2 kHz/div, 8 steps, 1-2-5 sequence. Accuracy within ±3% when calibrated with internal calibrator. Dispersion linearity within ±5%. Search position (uncalibrated) —minimum 20 kHz + 1 kHz/MHz of indicated frequency full scale (10 div).

3L10 DISPERSION CALIBRATOR
10.7-MHz carrier, 4-kHz crystal-controlled side-bands with ±0.1% accuracy.

COUPLED RESOLUTION
10 Hz to 500 Hz (+20°C to +30°C), coupled with calibrated dispersion positions, and separately switchable. Search position—approximately 10 kHz.

DISPLAY FLATNESS
Amplitude variation is within 2 dB over dispersions of 20 kHz or less.

MAXIMUM INCIDENTAL FM
IF within 5 Hz.
LO within 25 Hz + 1-Hz/MHz dial frequency.

INTERMODULATION
25 dB below full-screen deflection in the log mode for input levels up to —20 dBm.

INPUT IMPEDANCE
Approx 50 Ω and approx 600 Ω.

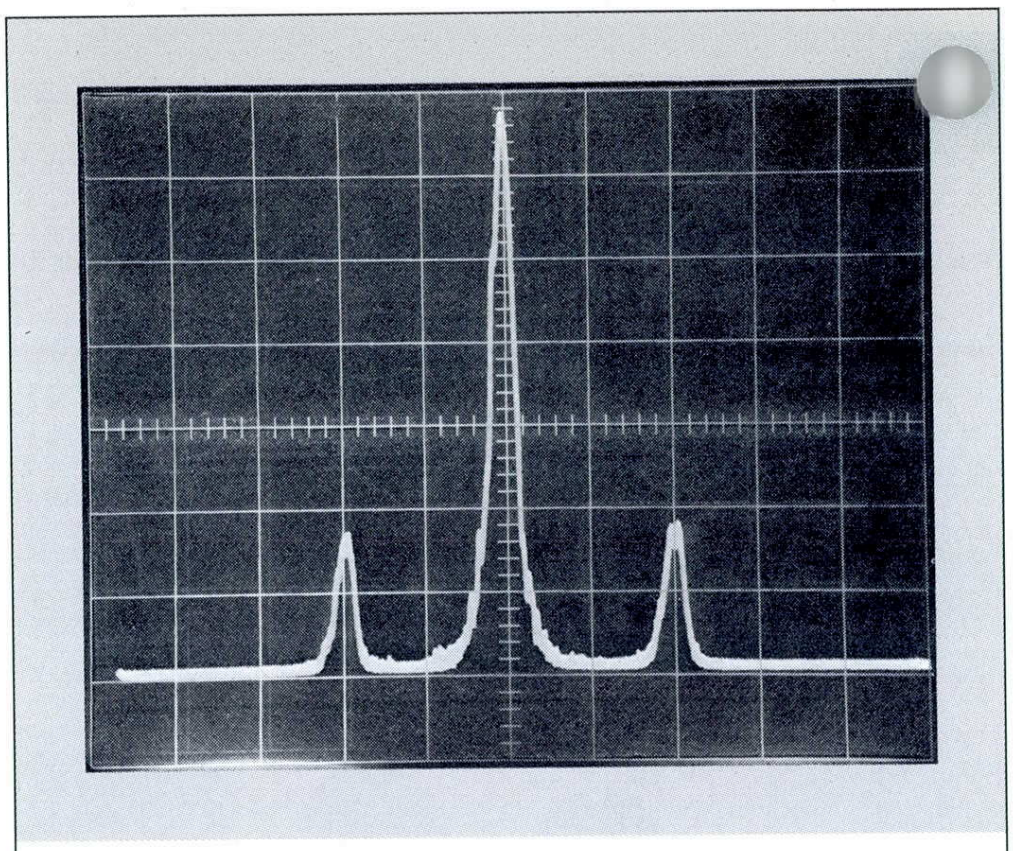
MAXIMUM INPUT POWER
+24 dBm at full RF attenuation, —20 dBm without RF attenuation.

RF ATTENUATOR
51 dB ±0.1 dB/dB in 1-dB steps.
½-watt maximum power-handling capability.

IF GAIN CONTROL
>60-dB range.

1L10 VERTICAL DISPLAY (6 DIVISIONS)
Log—50-dB dynamic range.
Linear—26-dB dynamic range.
Linear X10—26-dB dynamic range.
Video—approx 100 mV/cm (variable), ≤16 Hz to ≥10 MHz, approx 50-Ω input resistance.

3L10 VERTICAL DISPLAY (8 DIVISIONS)
Log—50-dB dynamic range.
Linear—20-dB dynamic range.
Video—100 mV/div (variable) DC to 50 kHz, approx 50-Ω input resistance.



STORED SPECTRAL DISPLAY

Stored waveform showing center frequency with two sidebands. Using single-sweep and storage allows measurement of frequency drift with spectrum analyzer unit.

RECORDER OUTPUT
DC-coupled, approx 600-Ω source resistance, 15-mV/div display in Linear mode, output linear with voltage.

1L10 WEIGHTS

Net weight	6 lb	2.7 kg
Domestic shipping weight	≈11 lb	≈5.0 kg
Export-packed weight	≈18 lb	≈8.2 kg

3L10 WEIGHTS

Net weight	6¼ lb	2.8 kg
Domestic shipping weight	≈10 lb	≈4.5 kg
Export-packed weight	≈17 lb	≈7.7 kg

1L10 INCLUDED STANDARD ACCESSORIES
Cable assembly, BNC to BNC, 2½ inches (012-0097-00); cable assembly, BNC-to-banana plug, 24 inches (012-0096-00); tini-plug (134-0052-00); two instruction manuals (070-0510-01).

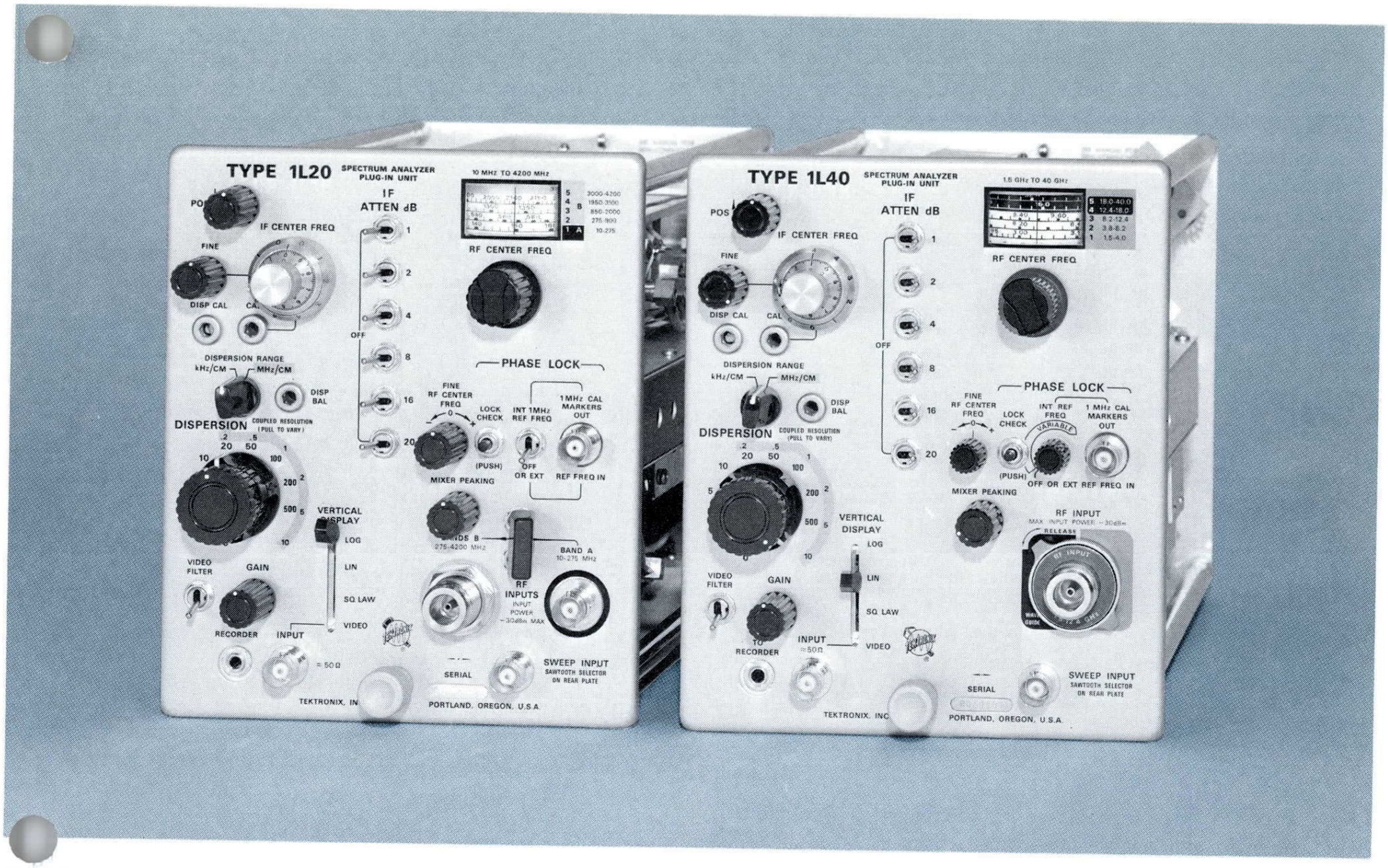
3L10 INCLUDED STANDARD ACCESSORIES
Tini-plug (134-0052-00); two instruction manuals (070-0521-00).

TYPE 1L10 SPECTRUM ANALYZER UNIT $1175

TYPE 3L10 SPECTRUM ANALYZER UNIT $1275

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

1L20 Multi-Band Spectrum Analyzer 1L40



Type 1L20 covers 10 MHz to 4.2 GHz

- ***INTERNAL PHASE LOCK***
- ***CALIBRATED DISPERSION TO 100 MHz***
- ***COUPLED RESOLUTION***
- ***AMPLITUDE VARIATIONS WITHIN 3 dB OR LESS***
- ***CONVENIENT WAVEGUIDE MIXERS WITH TYPE 1L40***
- ***RECORDER OUTPUT***

*Type 1L40 covers 1.5 GHz to 40 GHz**

Operating convenience and performance is now offered in multi-band plug-in units for all present Tektronix Type 530, 540, 550, or (with adapter) 580-Series Oscilloscopes. The Type 549 Oscilloscope adds further convenience to spectrum analysis—allowing storage and simultaneous comparison of spectral displays.

BUILT-IN PHASE LOCK circuit synchronizes the analyzer local oscillator with a stable reference frequency (internal 1 MHz or external 1 to 5 MHz). When the local oscillator is locked in phase to the reference frequency, the local oscillator stability approaches that of the reference frequency. This allows very narrow dispersion at high frequencies where the analyzer would normally be limited by oscillator drift, microphonics, and other perturbations. Phase lock can be used to view any signal within the tuning range of the analyzer.

CALIBRATED DISPERSION from 1 kHz/cm to 10 MHz/cm makes frequency measurement as easy and accurate as time measurement. Frequency differences can be read directly from the CRT.

COUPLED RESOLUTION from 1 kHz to 100 kHz greatly simplifies operation, providing narrow resolution bandwidth at narrow dispersion and wide resolution bandwidth at wide dispersion. Dispersion and resolution controls can be uncoupled and operated separately if desired, for optimized viewing of a particular signal.

*With optional accessories.

1L20 Multi-Band Spectrum Analyzer 1L40

TYPE	BAND	FREQUENCY RANGE	MINIMUM CW SENSITIVITY* 1-kHz RESOLUTION	MINIMUM CW SENSITIVITY* 100-kHz RESOLUTION
1L20	1	10 MHz to 275 MHz	≥ —100 dBm	≥ —80 dBm
	2	275 MHz to 900 MHz	≥ —110 dBm	≥ —90 dBm
	3	850 MHz to 2 GHz	≥ —100 dBm	≥ —80 dBm
	4	1.95 GHz to 3.1 GHz	≥ —95 dBm	≥ —75 dBm
	5	3 GHz to 4.2 GHz	≥ —90 dBm	≥ —70 dBm
1L40	1	1.5 GHz to 4.0 GHz	≥ —110 dBm	≥ —90 dBm
	2	3.8 GHz to 8.2 GHz	≥ —100 dBm	≥ —80 dBm
	3	8.2 GHz to 12.4 GHz	≥ —95 dBm	≥ —75 dBm
	OPTIONAL WAVEGUIDE MIXERS AND ADAPTER REQUIRED BEYOND 12.4 GHz			
	4	12.4 GHz to 18 GHz	≥ —90 dBm	≥ —70 dBm
	5	18 GHz to 40 GHz	≥ —80 dBm to 26.5 GHz	≥ —60 dBm
			≥ —70 dBm to 40 GHz	≥ —50 dBm

*Signal + noise = 2X noise

DIAL ACCURACY
± (2 MHz + 1% of dial reading).

CALIBRATED DISPERSION
1 kHz/cm to 10 MHz/cm in 1-2-5 sequence, 2 ranges (kHz/cm—MHz/cm). Accuracy of 10-cm display, throughout full range of IF center frequency control, within ±3% except at 2 MHz/cm (±5%) and 1 MHz/cm (±7%). Accuracy can be increased using internal 1-MHz crystal markers for calibration. Dispersion linearity within ±3%. Zero dispersion useful for PRF measurements.

BANDWIDTH RESOLUTION
1 kHz to 100 kHz, coupled with calibrated dispersion positions but separately switchable.

DISPLAY FLATNESS
Amplitude variations are within 3 dB over the full 100-MHz dispersion range (or less) except:
a) over 50 MHz in Band 1 with Type 1L20.
b) within 6 dB from 12.4 GHz to 40 GHz with Type 1L40.

INCIDENTAL FM (LO + IF)
300 Hz or less at LO fundamental when phase locked.

PHASE LOCK
Internal 1-MHz reference. External input accepts 1-MHz to 5-MHz signals from 1 V to 5 V peak to peak.

INPUT IMPEDANCE
Approx 50 Ω.

MAXIMUM INPUT POWER
—30 dBm for linear operation, +15 dBm (25 mW) safe diode power limit.

IF ATTENUATOR
51 dB in 1-dB steps, ±0.1 dB/dB.

IF GAIN CONTROL
>50-dB range.

IF CENTER FREQUENCY
±25-MHz range from 5 MHz/cm to 0.2 MHz/cm, ±10 MHz at 10 MHz/cm. ±2.5-MHz range in all kHz/cm positions. FINE control has ±1-MHz and ±50-kHz range in MHz/cm and kHz/cm modes respectively.

VERTICAL DISPLAY (6 cm)
Log—≥40-dB dynamic range.
Linear—≥26-dB dynamic range.
Square Law—≥13-dB total dynamic range.
Video— ≤16 Hz to ≥10 MHz, approx 50-Ω input resistance.

RECORDER OUTPUT
12 mV to 20 mV with 6-cm linear display.

WEIGHTS

Net weight	7½ lb	3.4 kg
Domestic shipping weight	≈14 lb	≈6.4 kg
Export-packed weight	≈20 lb	≈9.1 kg

INCLUDED STANDARD ACCESSORIES
Patch cord, BNC to banana (012-0091-00); plug protector (134-0076-00); tini-plug (134-0052-00); two instruction manuals (070-0519-01 for Type 1L20, 070-0904-00 for Type 1L40).

TYPE 1L20 SPECTRUM ANALYZER UNIT $1950

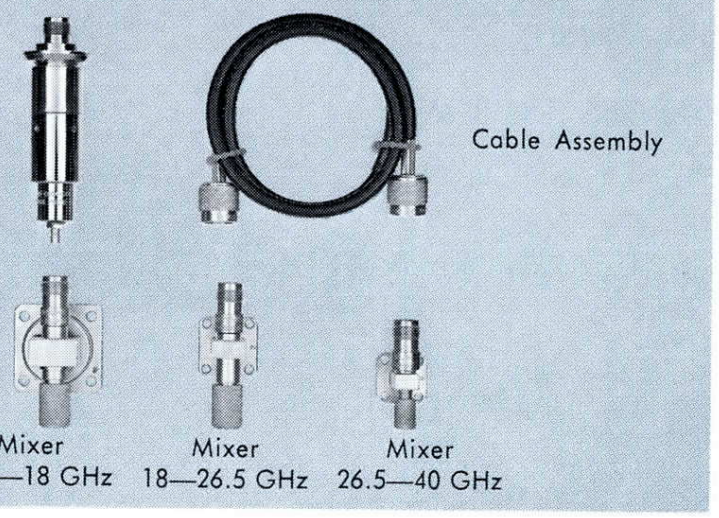
TYPE 1L40 SPECTRUM ANALYZER UNIT $2150

OPTIONAL ACCESSORIES

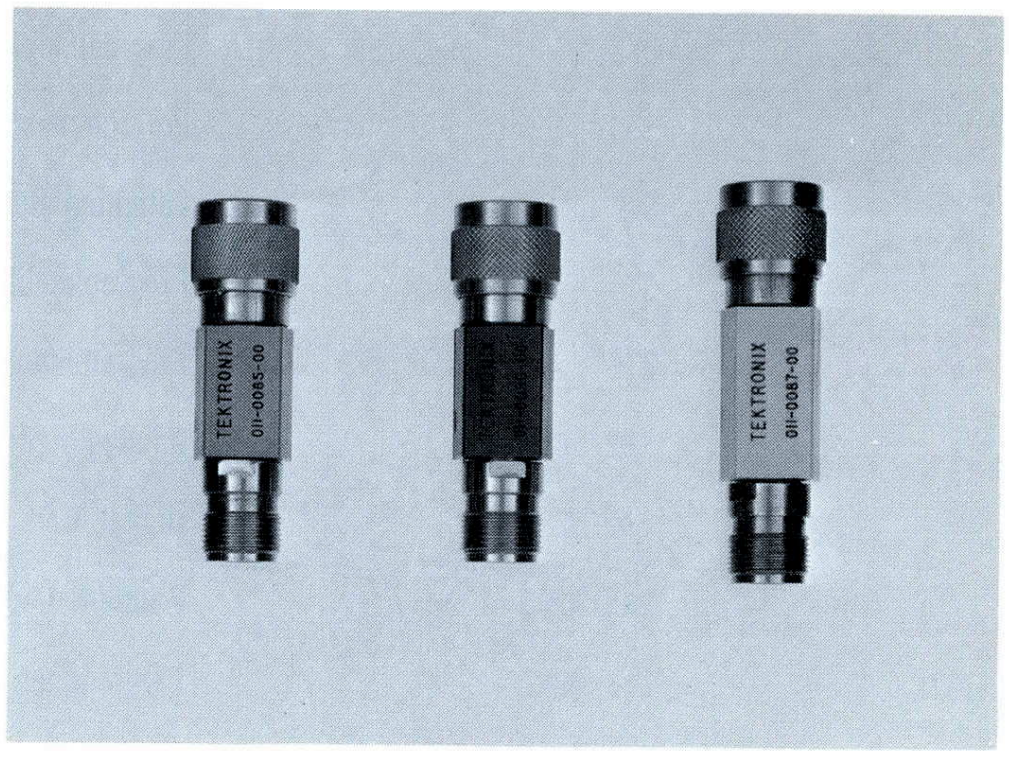
The following accessories extend the operational range of the 1L40 from 12.4 GHz to 40 GHz. The waveguide mixer adapter and cable are required for use with the waveguide mixers.

Waveguide Mixer Adapter (119-0104-00) ..... $ 44.00
Cable Assembly (012-0115-00) ..... $ 9.20
Waveguide Mixer 12.4—18.0 GHz (119-0097-00) ..... $ 77.00
Waveguide Mixer 18.0—26.5 GHz (119-0098-00) ..... $ 88.00
Waveguide Mixer 26.5—40.0 GHz (119-0099-00) $138.00

OPTIONAL WAVEGUIDE MIXERS



Attenuators are all supplied with Type N fittings. See accessory section for adapters for other series. Frequency range is DC to 12.4 GHz. Power rating is 2 W average, 300-W peak. Impedance is 50 Ω.



10-dB attenuator, order 011-0085-00 ..... $ 45
20-dB attenuator, order 011-0086-00 ..... $ 45
40-dB attenuator, order 011-0087-00 ..... $ 55

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Digital Instruments & Automated Testing Systems

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The widespread use of integrated circuits in the electronics industry, and the promise of even greater use in the near future, has focused attention on the need of externally programmable digital systems. To meet these needs Tektronix has developed a family of digital system components that meets IC-testing needs in manual, semi-automatic, or fully-automated measurement systems. Although these system components have been designed primarily with the integrated circuit tester in mind, their flexibility suggests their use for testing of circuit cards, cables, complete instruments, etc.

BASIC SAMPLING TECHNIQUES

The current state of the electronics art does not permit the direct cathode-ray tube display of fractional-nanosecond rise-time low-level signals. Risetimes in the order of 0.35 ns can be displayed on a CRT if the signal is at least several volts in amplitude.

An inherent limitation in linear amplifiers is the compromise necessary between bandwidth and gain. A high-gain amplifier is a low-bandwidth amplifier; and conversely, wide-band amplifiers are necessarily low-gain amplifiers. For any particular configuration, gain times bandwidth is nearly a constant, so anything done to increase the gain will proportionately reduce the bandwidth and vice versa. The gain-bandwidth product limitation of linear amplifiers restricts the display of millivolt signals on a CRT to the 50 to 300 MHz region.

The sampling technique permits the quantitative display (on a CRT) of a facsimile of fractional-nanosecond risetime low-level signals. In sampling, many cycles of an input signal are translated into one cycle of low-frequency information. The change takes place at the input, or sampling bridge. Since only the sampling bridge is subjected to the input signal high frequencies, and all the amplification takes place at relatively low frequencies, the performance of a sampling system is not dependent on the gain-bandwidth limitations of conventional amplifiers.

However, the sampling technique introduces some limitations of its own. The sampling process being described is restricted to repetitive signals of low amplitude (typically 1 or 2 volts peak to peak), from low-impedance sources. Fortunately, most fractional-nanosecond risetime signals exist in low impedance environments and are generally low amplitude. Piping the signal from the circuit under test to the input of the sampling oscilloscope vertical channel requires a more sophisticated technique than lower-bandwidth systems. In spite of its limitations, sampling can measure fast signals that otherwise defy observation.

A sampling system looks at the instantaneous amplitude of a signal during a specific small time period, remembers the amplitude, and displays a single dot on the CRT corresponding to the amplitude. After a dot is displayed for a fixed amount of time, the system again looks at the instantaneous amplitude of a different cycle of the input signal. Each successive look, or sample, is at a slightly later time in relation to a fixed point of each signal cycle. Each sample is displayed as a spot on the CRT. Generally the vertical position of the dot represents the equivalent time when the sample was taken. After many cycles of the input signal, the sampling system has reconstructed and displayed a single facsimile made up of many samples, each sample taken from a different cycle of the input signal.

Fig 1 illustrates the equivalent time reconstruction of a repetitive squarewave. The CRT display is a series of dots rather than the conventional oscilloscope continuous presentation. In the illustration, a series of samples is taken of the input signal. After each sample, when memory has been established and stabilized, the CRT is unblanked and a dot appears. A large number of such dots form the display.

The number of dots per horizontal unit of display is called dot density. The dot density of a display is controlled by the operator to provide the best compromise between resolution and repetition rate of the display. Since only one sample is taken from any particular input cycle, the time required to reconstruct a display is a function of the dot density selected and the repetition rate of the signal. The higher the dot density selected (for higher resolution), the longer the time required to construct the equivalent time display. The higher the repetition rate of the signal, the less time required to reconstruct the waveform (limited by a maximum repetition rate of the system).

Sampling requires repetitive input signals, although not necessarily signals with constant repetition rate. The equivalent time between dots is determined by the time delay between the fixed point on the signal at which triggering occurs, and the point at which the sample is taken. Since both time references (triggering-time and sample-time) are taken from the same cycle of the signal, the signal repetitions do not have to be identical in amplitude, time duration, and shape. Any differences in the individual cycles show as noise or jitter in the reconstructed display.

Sampling systems have maximum signal repetition rates at which samples can be taken and accurately displayed. The primary limit is the time required for the preamp and the AC amplifier to stabilize after a sample has been taken.

Signals below 100 kHz may have considerable repetition rate jitter and still the sampling oscilloscope will present a sample of each cycle, without display jitter. For signals with a repetition rate higher than 100 kHz, the timing unit holds off retriggering for a maximum of about 10 μs. This means that a sample will not be taken from every cycle of a high repetition rate signal. Only those cycles are sampled which occur after the end of the holdoff. If the signal is truly repetitive and each cycle is identical, these "missed" cycles are of little significance.

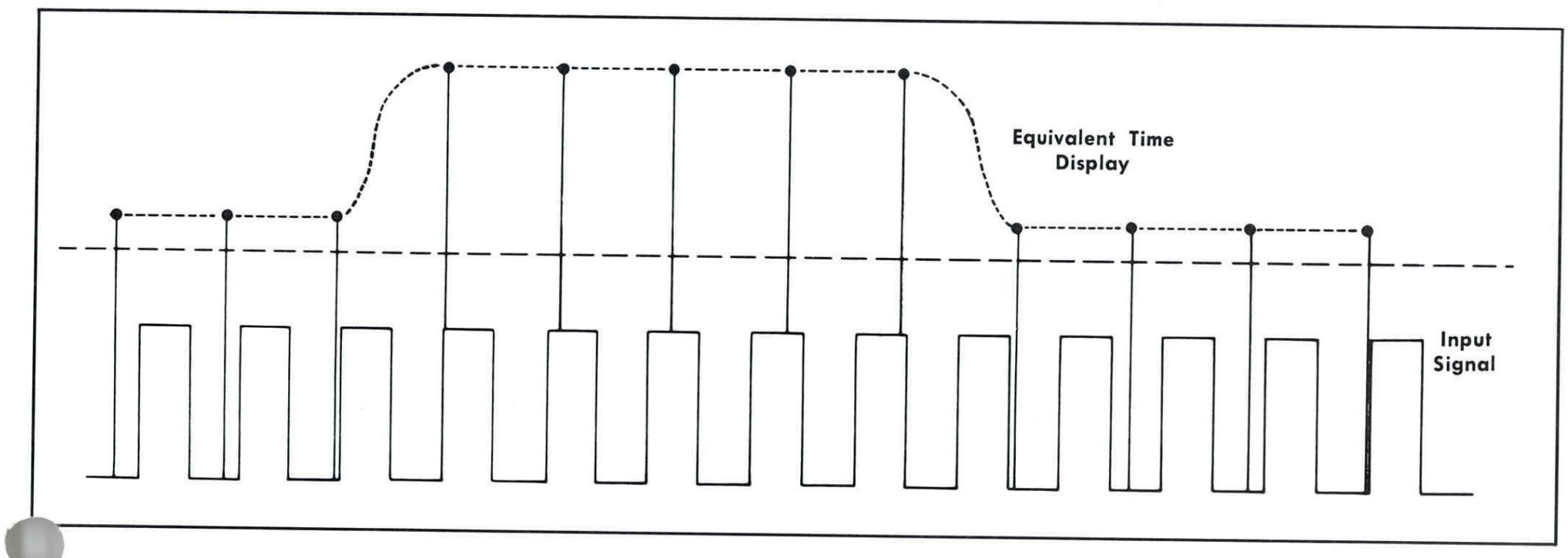


Fig 1. Equivalent-time display of repetitive real-time signal by means of the sampling technique.

System Instruments on Your Bench

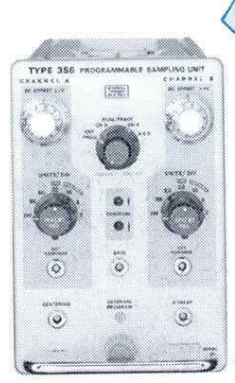
Type 568/230 Digital Oscilloscope System provides digital readout of measurements that are displayed in analog form on the CRT. They enable the engineer, technician or production worker to make dynamic switching time measurements with greater speed, convenience and repeatability than is possible by making measurements directly from the cathode-ray oscilloscope display. Typical measurements include pulse voltages, risetime, delay time, storage time, pulse width and many other specific measurements.

All of the measurement functions of the Type 568/230 can be externally programmed for use in high-speed automated measurement systems. The Type 568/230 can make more than 100 dynamic measurements per second, and data output connectors provide measurement results in convenient BCD code. The programming is accomplished with the use of Tektronix Program Units or by programming 157 parallel program lines using negative logic with true being ground or <2 V, and false being open or >6 V.

Programmable plug-in units extend the automated measurement capabilities of the Type 568/230. The Type 3T5 and 3T6 Programmable Sampling Units have a programmable sweep range that extends from 100 ps/div to 0.5 s/div.

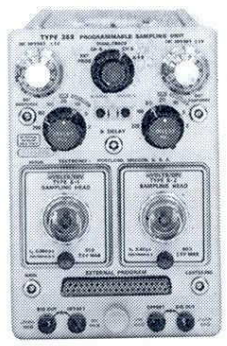
The Type 3S5 and Type 3S6 Dual-Trace Programmable Units feature Sampling Heads and programmable vertical deflection factors and DC offset.

Sampling Heads provide a choice of system measurement capabilities. Select the measurement performance you need today and update your performance with future Sampling Heads.

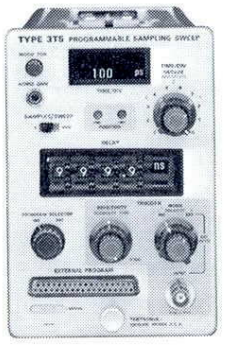


Type 3S6

Type 3T6



Type 3S5



Type 3T5

Type S-1
350 ps, 50 Ω

Type S-2
75 ps, 50 Ω

Type S-3
350 ps
100 kΩ, 2.3 pF

Type S-4
25 ps, 50 Ω

Type S-5
1 ns, 1 MΩ

MORE TO COME

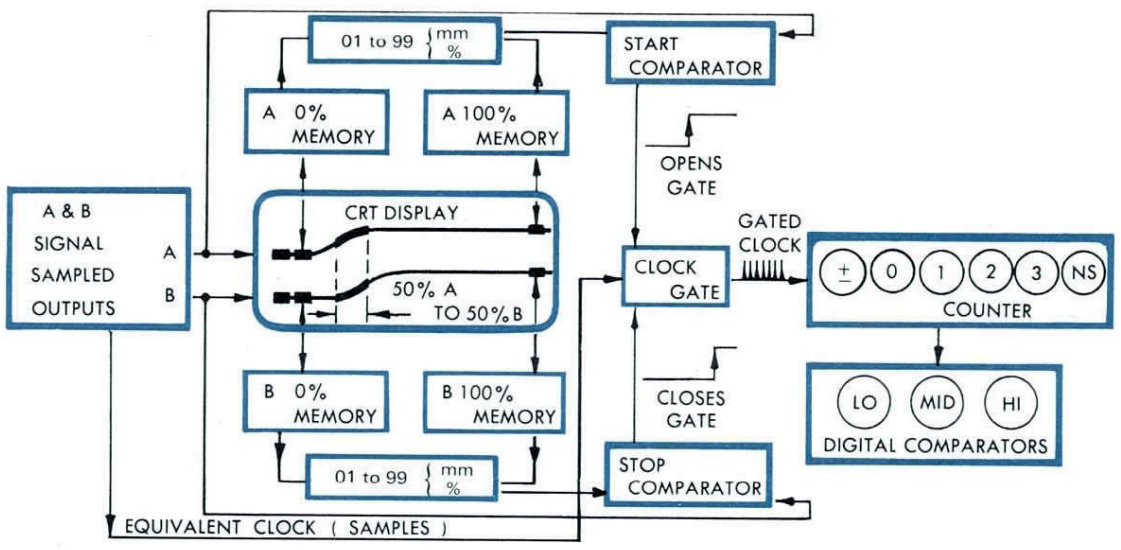
The Digital Unit Type 230

The heart of Tektronix Digital systems is the Type 230 Digital Unit which operates in conjunction with programmable sampling units. The diagrams below illustrate how the counts are derived for voltage and time measurements.

The sampling plug-ins construct a display, with each signal repetition contributing a sample. Because the samples per division are accurately controlled, the count of samples between 2 selected portions of a waveform is an accurate measure of the elapsed time. 0% to 100% intensified zones are generated that are variable in .5-cm increments by means of a 20-position switch. By using these zones and the signal delay, the user positions the 0% and 100% zones as desired. After the first sweep, the amplitudes corresponding to the zones are stored in memory circuits. Changes in amplitude automatically re-establish new 0% and 100% memory amplitudes.

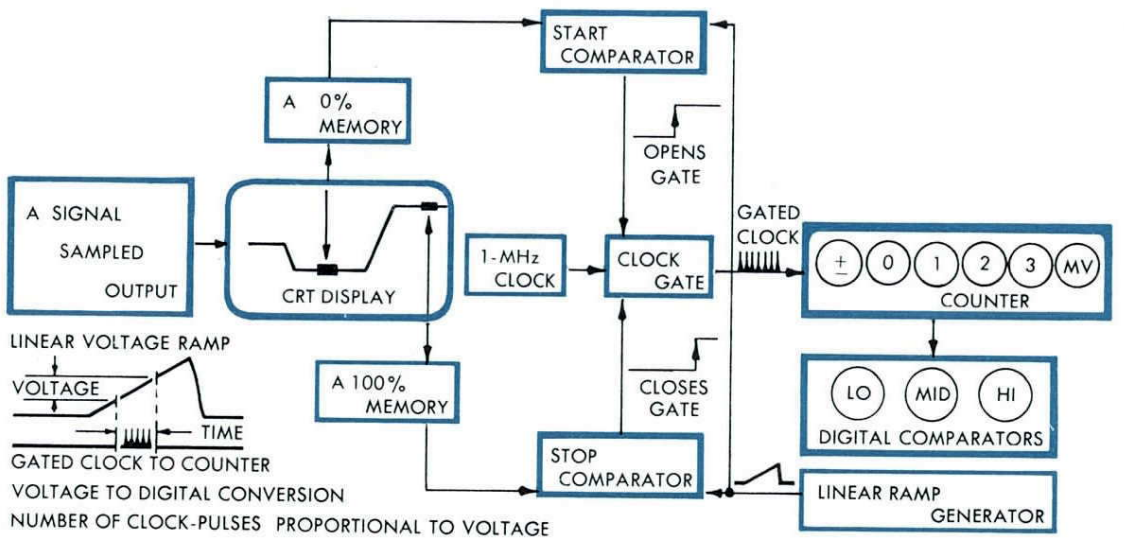
In a typical time measurement, digitally selected voltage divider taps between the 0% and 100% memory outputs are set for start and stop timing in 1% (or 1 mm) increments of either waveform of a dual-trace display. The selected percentage reference levels are then compared against the sampled input waveform on the second sweep. Coincidence of the waveform amplitudes with the selected percentage reference amplitudes is sensed by comparators which open and close the clock gate to the digital counter. The CRT display can be intensified for the duration of the measured interval as a reference check. The number of clock pulses are read out digitally in nanoseconds, microseconds, milliseconds, or seconds with decimal points included.

To measure voltage, start and stop comparators gate 1-MHz clock pulses for the period of time that a linear ramp voltage is at values between the 0% and 100% amplitudes. The number of clock pulses is proportional to the voltage between the selected measurement points. Readout is in mV and V with decimal points included.



TYPE 230
Time Measurement

TYPE 230
Voltage Measurement



Tests Typically Made by Automated Testing Systems

Input pulse
- *Amplitude*
- *Width*
- *Period*
- *Risetime*
- *Falltime*

Delay between input pulses

Output pulse
- *Amplitude*
- *Width*
- *Period*
- *Risetime*
- *Falltime*
- *Overshoot*
- *Undershoot*

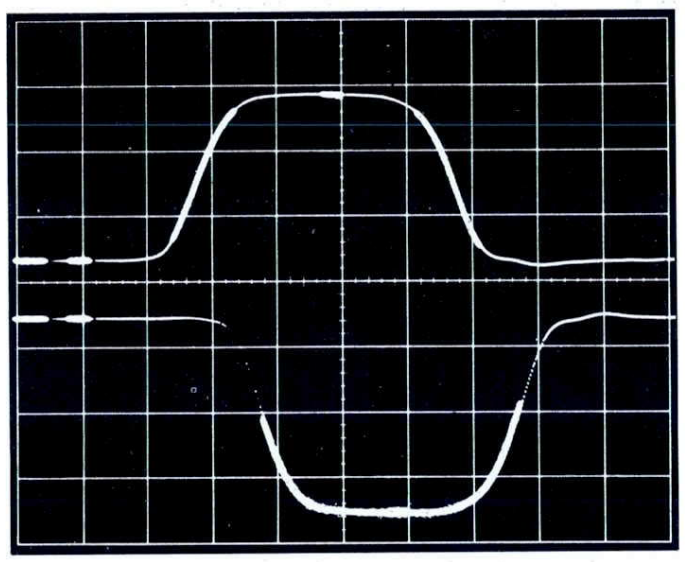
Delay time
Storage time
Turn on time
Turn off time
Propagation delay
Time to voltage level
Time between voltage levels

Diode forward and reverse recovery time
Noise immunity
Noise feed through
Truth table verification

Input voltage
Output voltage
Set voltage
Reset voltage
Preset voltage
Offset voltage
Breakdown voltage
Saturation voltage

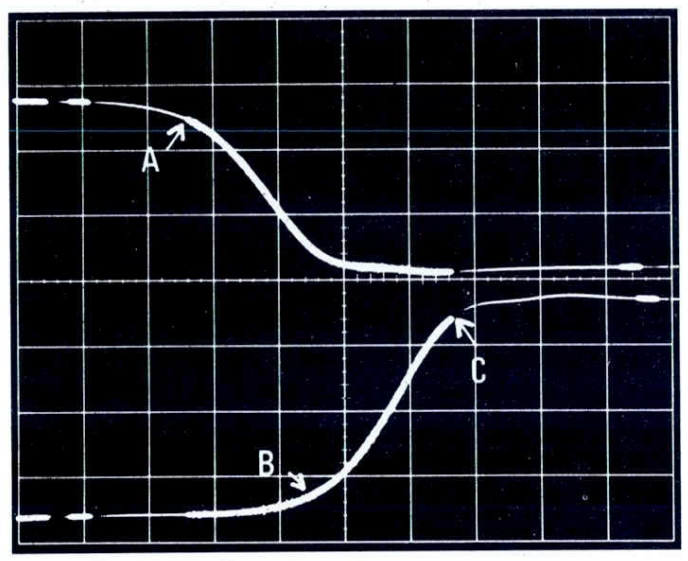
Input pulse
Amplitude
Risetime
Falltime
(Multiple Exposure)

Output pulse
Pulse width



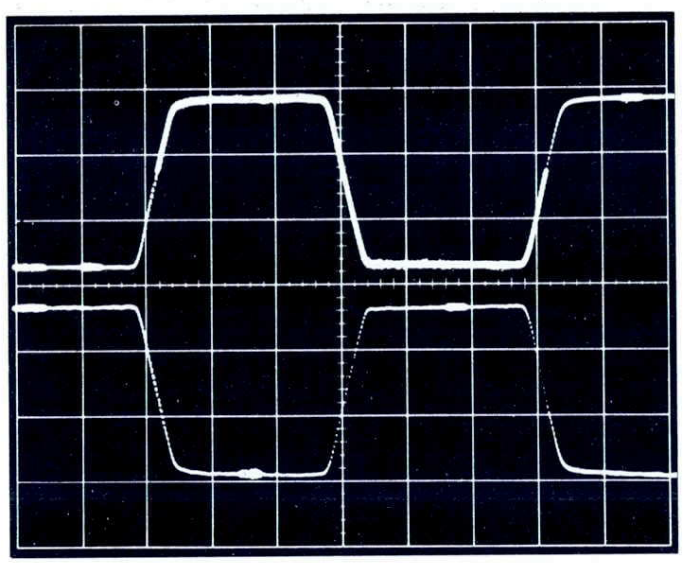
Input pulse
Storage time
A to B

Output pulse
Turn off time
A to C



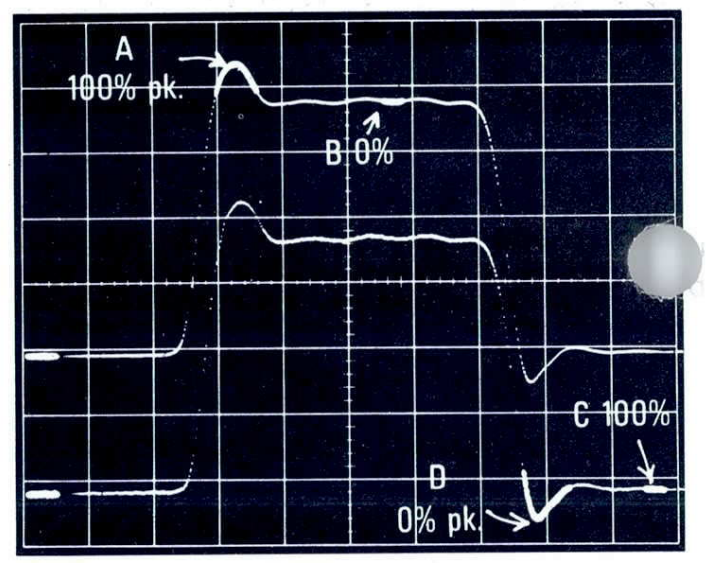
Input pulse
Period

Output pulse
Amplitude



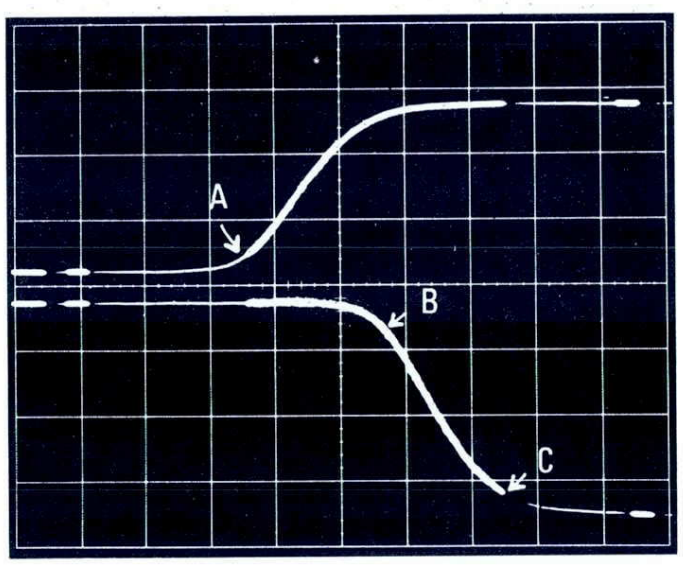
Output pulse
Overshoot
B to A

Negative overshoot
C to D

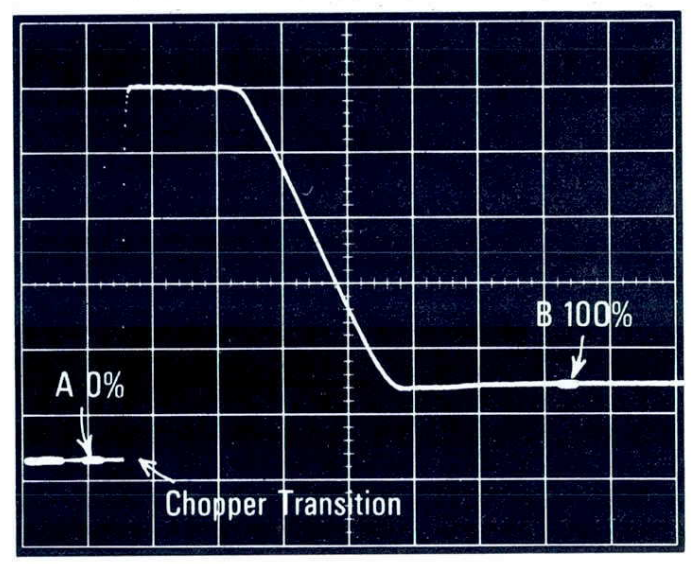


Input pulse
Propagation delay
A to B

Output pulse
Turn on time
A to C

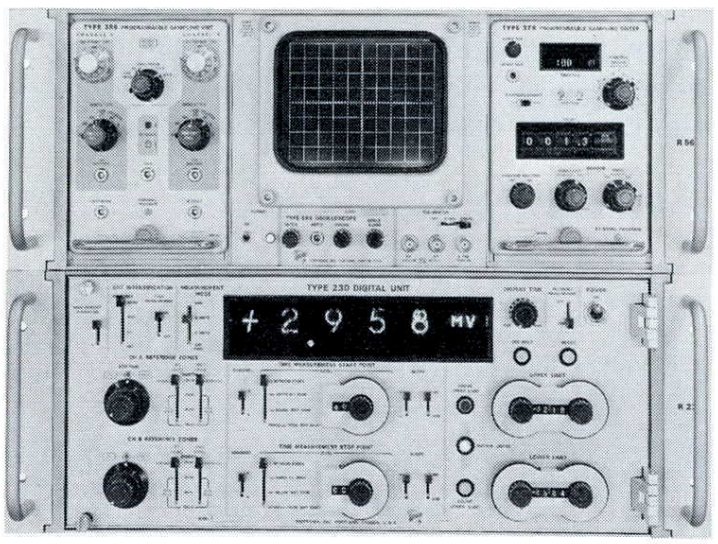


Output pulse
Collector to emitter or Source to drain
Saturation Voltage
A to B

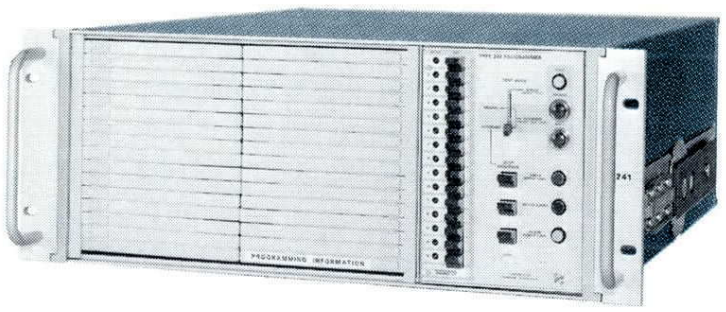


Memory and Control for Your System

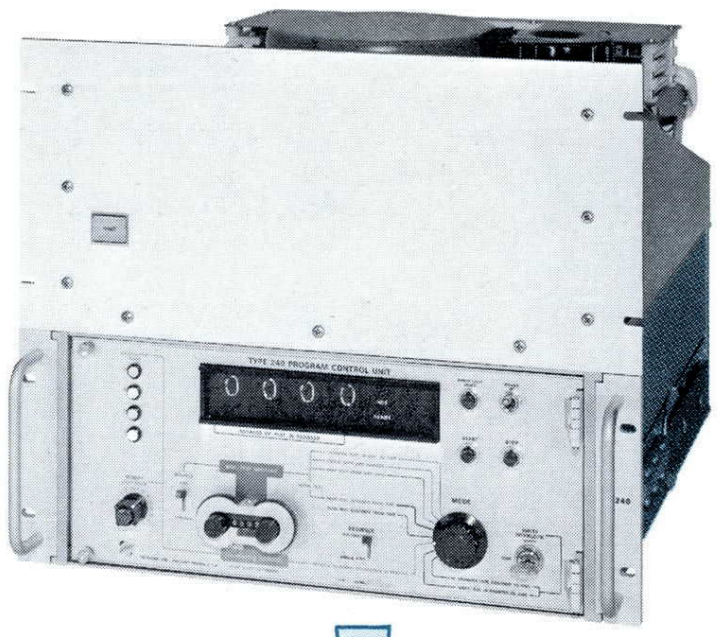
Tektronix digital instruments are designed for use in your automated measurement systems. Their modular construction lets you put together a complete measurement system designed to do your specific job.



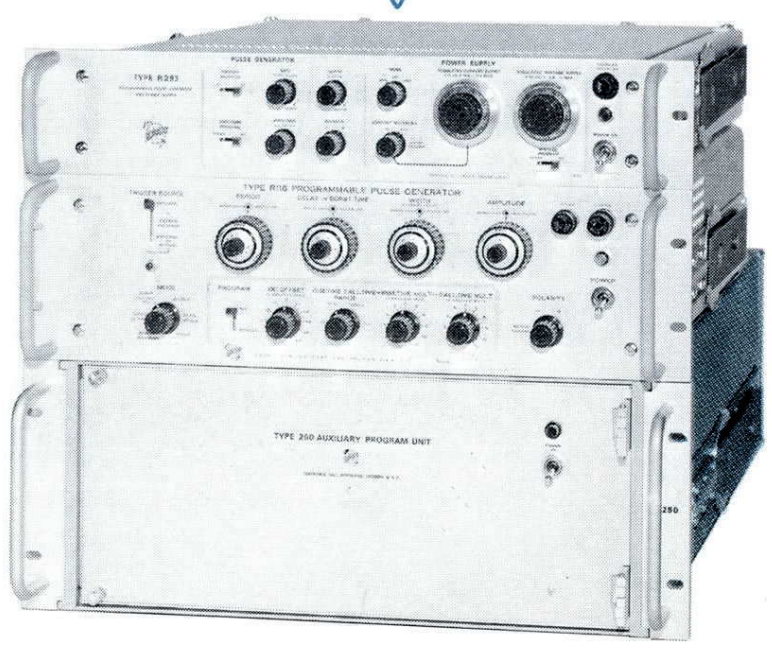
Memory and Control includes several functions. Control provides programming for the Stimulus, Fixture and Measurement devices and is done via parallel lines using digital methods. Programming is the function of converting data (stored in Memory) into usable logic form and distributing it to the instruments to be programmed. Up to 576 lines may be programmed. Memory is used to store programming data so that measurements which must be frequently repeated may be recalled rapidly and accurately. Memory options include a magnetic disc with up to 1600 measurement storage capability and punched tape with measurement storage capability limited only by the length of tape used. For very simple systems a program card memory is available which can use up to 15 measurement program cards.



TYPE 241 PROGRAMMER provides up to 15 measurement programs for the Type 568/230. Programs can be manually or remotely selected. The Type 241 will automatically sequence through up to 15 programs, stopping on out-of-limits measurements.



TYPE 240 PROGRAM CONTROL UNIT programs the Type 568/230 with up to 1600 measurement programs, stored in a Disc Memory or Punched Tape Reader. Additional units may be programmed by adding the Type R250 Auxiliary Unit.



TYPE R250 PROGRAM AUXILIARY UNIT adds additional programming capabilities to the Type 240 and provides programming and buffering for pulse generators, power supplies and other equipment. Customer engineering and design is required with the Type R250.

Programming Digital Measurements

Once a user has become familiar with the Type 230/568 System (with sampling plug-ins) and has determined that some repetitive testing is required, the Type 241 Programmer is a logical choice for up to 15 measurements. There is sufficient external programming capability to control a Type 230/568/3T5/3S5 and an additional 14 lines for external equipment (159 total lines). The programmer may be used manually or in the automatic sequence modes. Measurement limits may be programmed and out-of-limit conditions can stop the measurement sequence if desired.

A system composed of these units is ideal, both for bench use where similar tests are being conducted often, and for small pilot runs where devices are being characterized.

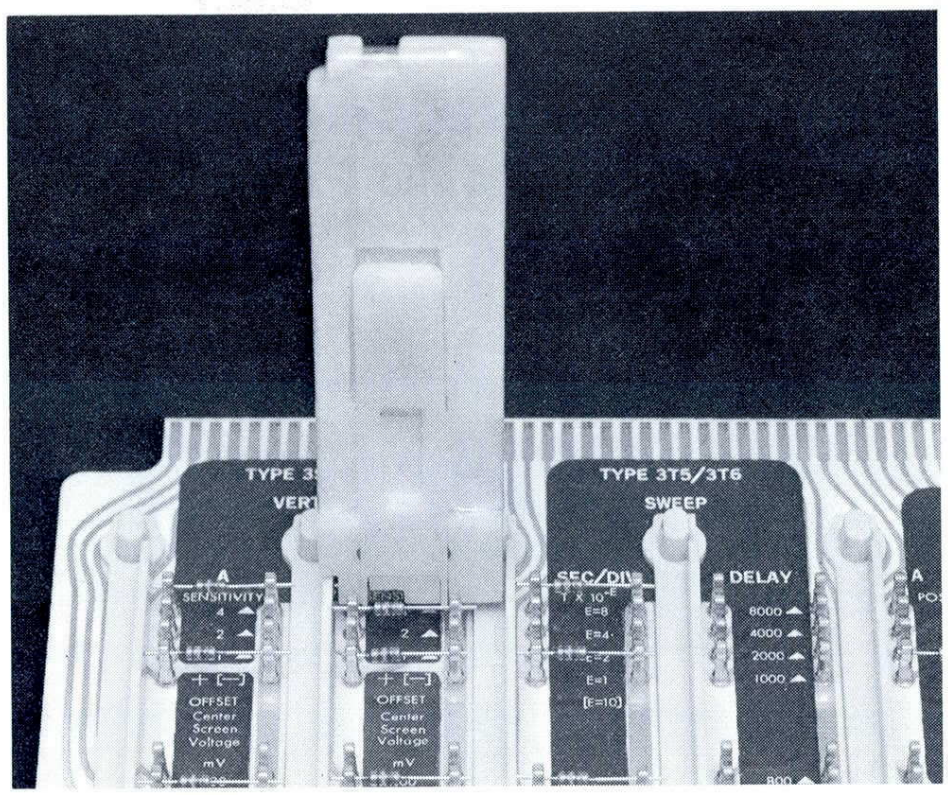


Fig 1. Type 241 program card with diode insertion tool. The card and tool are polarized so the diodes cannot be inserted incorrectly.

To prepare a program the user inserts the diodes provided into special mounting clips on the card with a special tool. Up to 15 different measurements may be programmed for any measurement sequence. The Type 241 also has storage space for 15 additional program cards. Most individual measurements require 15 to 20 diodes to be inserted.

An important feature of all Tektronix externally programmed digital systems is the high-speed program mode of operation. When the system is operating in this mode, the time base runs at a low-sample density of 100 samples per sweep when the instrument is not measuring. During the measurement portion of the sweep, however, 1000 samples are used for greater resolution. This feature eliminates wasted samples and allows testing rates well in excess of 100 measurements/second.

A unique feature of the external program mode is that measurements may be made that can not be performed in the manual mode. The figures below illustrate two such applications. In addition, if printed data output is required, printers are commercially available to connect directly to the Type 230.

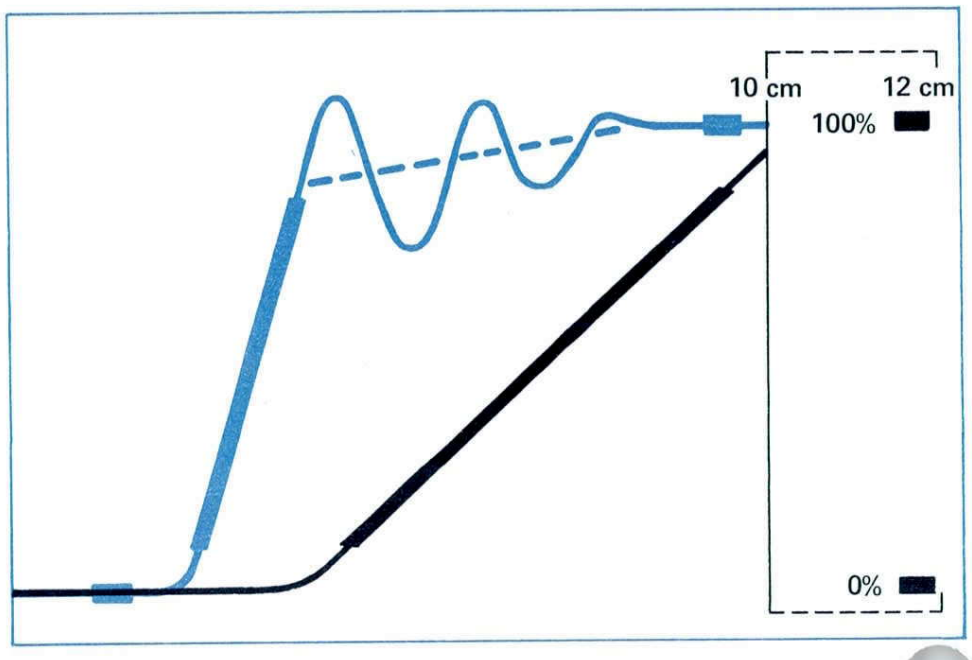


Fig 2. Externally programming the 0% and 100% to 12 cm keeps the memories from discharging after each sweep. A faster sweep may then be used for additional resolution in risetime measurements where ringing or dribble up is present.

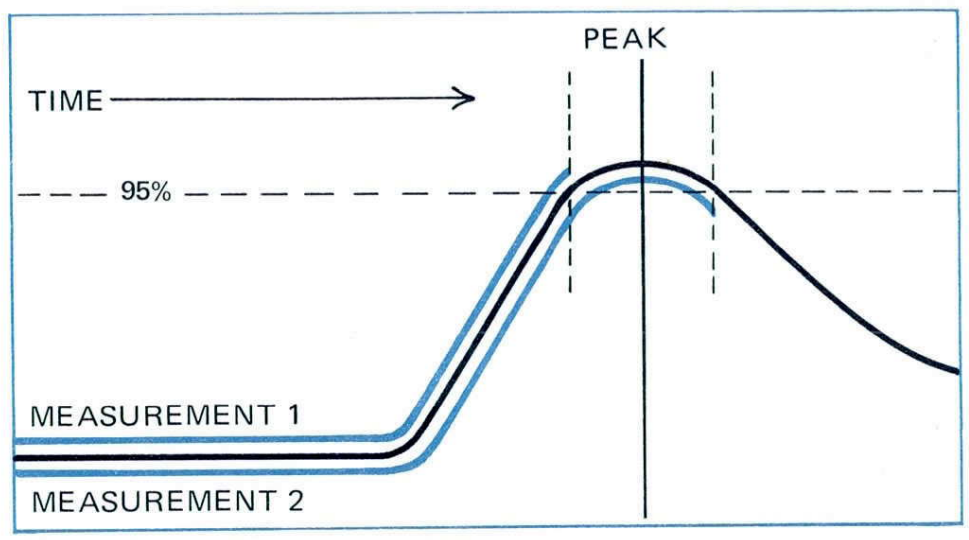
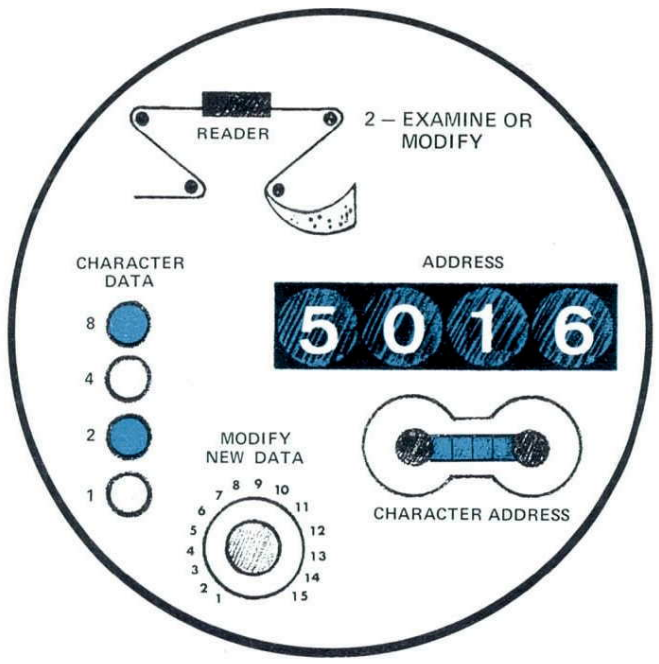
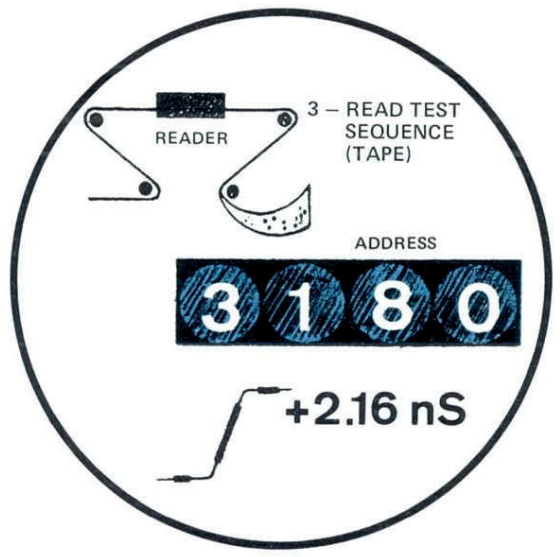


Fig 3. External programming allows inhibiting the counter reset in time-to-peak measurements. Thus two consecutive counts may be added (and divided by two) to obtain an average value.

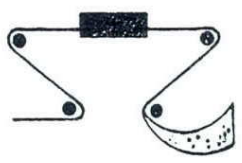
Programming Digital Measurements

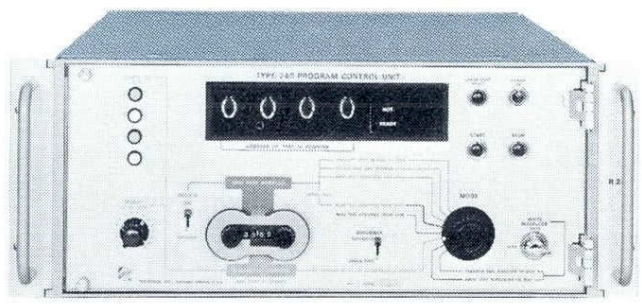




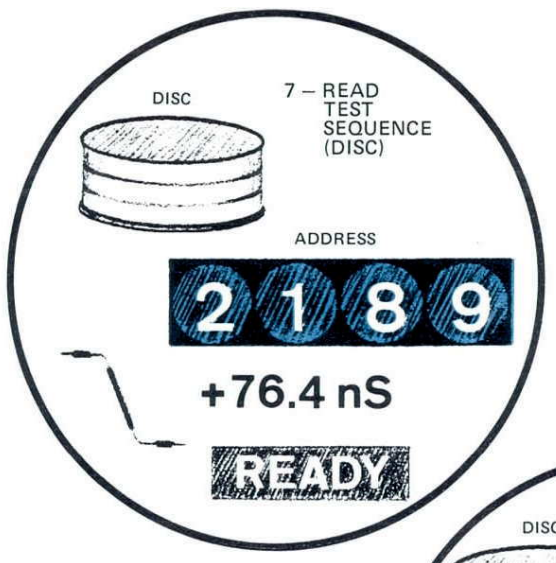
PUNCHED TAPE SYSTEM
(1) EDITING, MODIFY, DUPLICATE
(2) WRITE PROGRAMS EFFICIENTLY
(3) STOP ON LIMITS

4 MEASUREMENTS / SEC

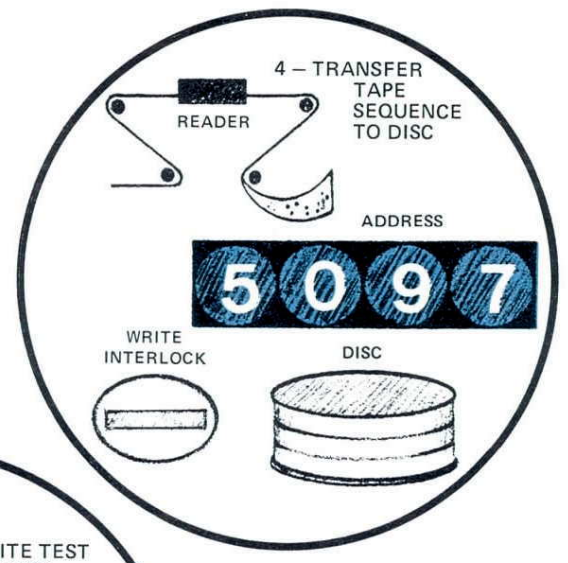


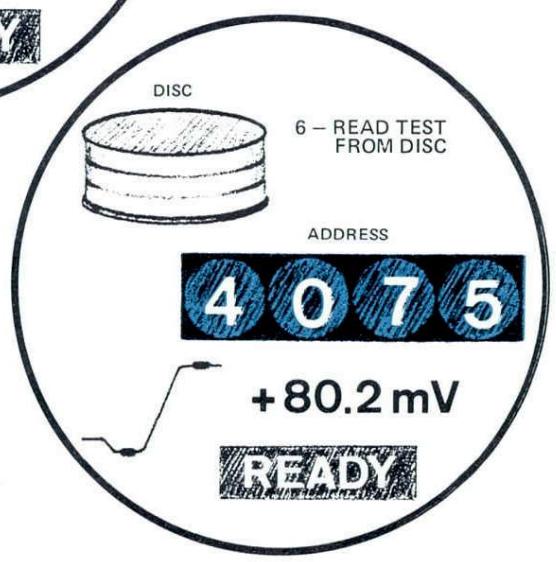


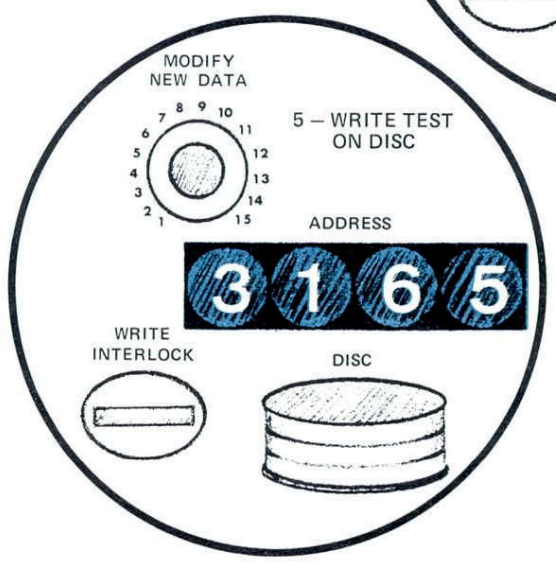
TYPE 240 – ADD DISC
(4) LOADS DISC
(5) MODIFY DISC DATA
(6) MAKE SINGLE MEASUREMENT
(7) BRANCHING AND DIAGNOSTIC ROUTINES, SORTING AND CLASSIFYING



100 MEASUREMENTS / SEC



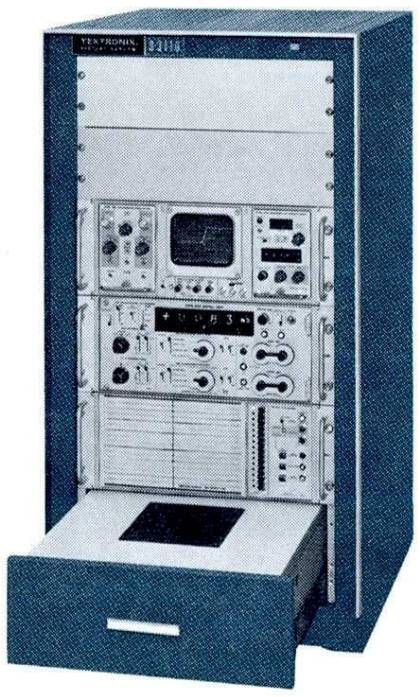




PROGRAMMING MODES OF THE TYPE 240. In the tape system above, the reader loads the shift register which allows: (1) a complete program tape to be punched; (2) program characters to be easily modified; (3) a complete measurement sequence to be made. In the disc system the random access disc loads the shift register which allows: (4) load shift register with tape reader and write data on disc; (5) store modified data on disc sector selected; (6) a single measurement to be made and; (7) a measurement sequence to be made (return to ready at sequence end).

Tektronix Automated Testing Systems

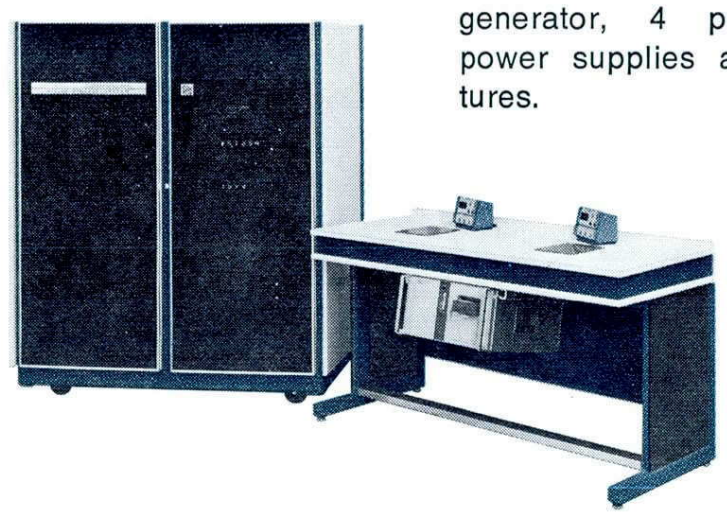
Tektronix Automated Testing Systems use Tektronix Catalog products and add additional equipment such as programmable pulse generators, programmable power supplies, fixtures, equipment racks and other equipment. Tektronix does the systems engineering and supplies a digital measurement system ready to do your measurement job.



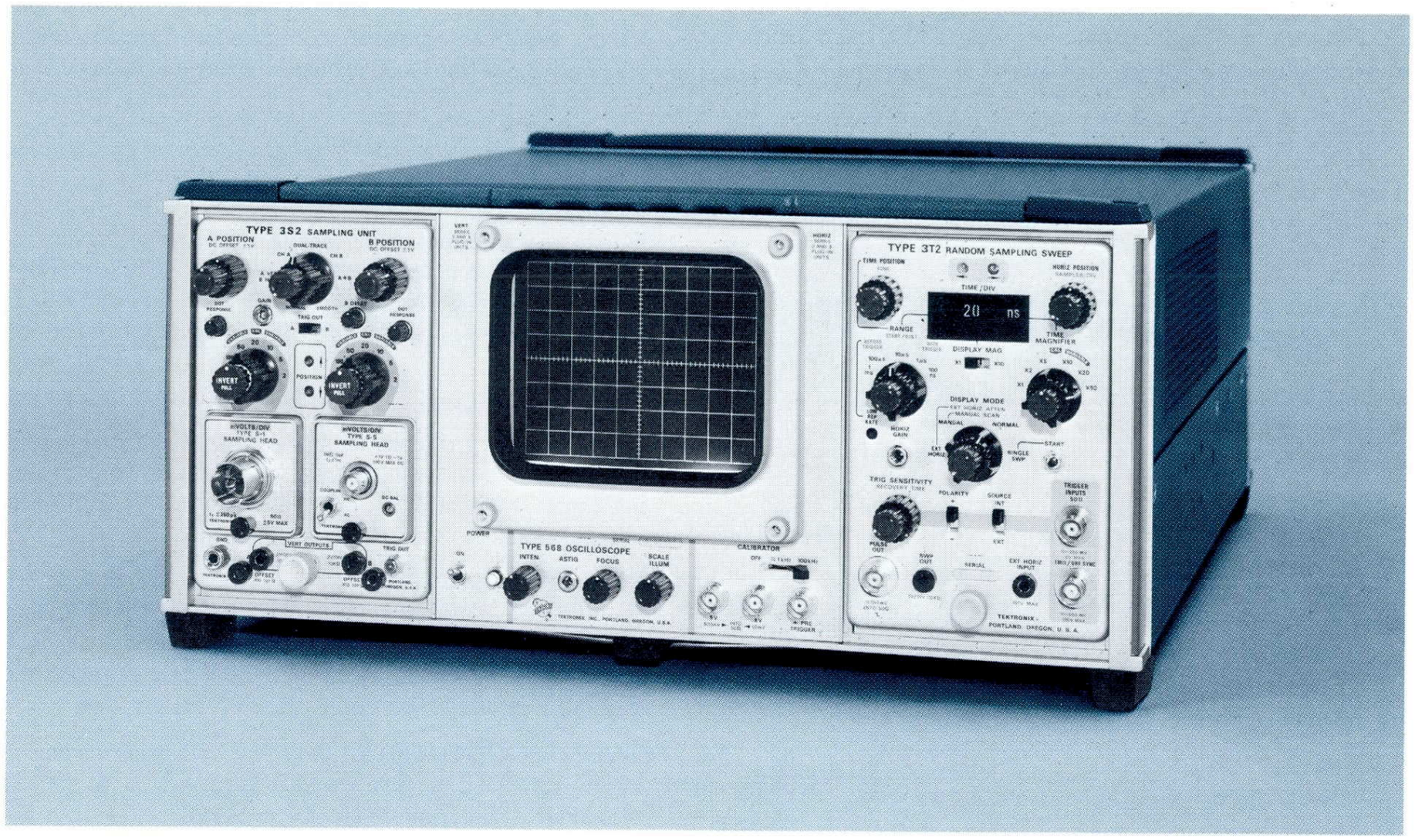
TYPE S-3110 Automated Testing System consists of the Type 568/230 with Type 241 Program Unit providing up to 15 automatic measurements.

TYPE S-3120 Automated Testing System consists of the Type 568/230 with the Type 240 Program Control Unit, a Disc Memory and Punched Tape Reader. It includes a pulse generator and 2 power supplies.

TYPE S-3130 Automated Testing System consists of the Type 568/230/240 with the Type R250 Auxiliary Program Unit and a Disc Memory and Punched Tape Reader. It also includes a programmable pulse generator, 4 programmable power supplies and test fixtures.



TYPE S-3150 is a high-speed, disc-programmed, dynamic and DC tester for digital integrated circuits. Basically a Type S-3130, the Type S-3150 adds a small computer (DEC PDP-8/L) for data acquisition and program writing and a new test station containing programmable fixturing.



- ***ANALOG DISPLAYS OF ANALOG/DIGITAL MEASUREMENT SYSTEM***
- ***PROVIDES MEASUREMENT INFORMATION FOR TYPE 230 DIGITAL UNIT***
- ***ILLUMINATED NO-PARALLAX GRATICULE***
- ***SOLID-STATE DESIGN***

Type 568 and Type R568 Readout Oscilloscopes are designed for use with 2- and 3-series plug-in units in both the vertical and horizontal deflection systems. When used together with the Type 230 Digital Unit, digital readout of measurements (in addition to the analog display on the CRT) makes the measurements faster, more convenient, and more accurate.

Connectors on the rear provide measurement information for the Type 230 Digital Unit, couple trace-brightening information from the Type 230 to the Type 568, and provide input and programming information for programmable plug-in units.

The Types 568/R568 are designed mainly for use in digital measurement systems, but through use of amplifier, spectrum analysis, and time-base plug-in units, they may be used in other applications that do not require digital readout.

Through use of solid state components, the Types 568/R568 offer reliable operation with low heat dissipation.

CHARACTERISTIC SUMMARY

VERTICAL

Vertical deflection characteristics are extremely flexible through use of 2-Series and 3-Series Amplifier Plug-In Units. See chart for plug-in units that provide digital readout when used with a Type 230 Digital Unit.

HORIZONTAL

Horizontal deflection characteristics are extremely flexible through use of 2-Series and 3-Series Amplifier and Time-Base Units. See chart for plug-in units that provide digital readout when used with a Type 230 Digital Unit.

CRT

DISPLAY AREA—8 x 10 div. (Each major div = 1 cm.)

ACCELERATING VOLTAGE—3.5 kV.

PHOSPHOR—P2.

OTHER

AMPLITUDE CALIBRATOR—5 V and 0.5 V into $\geq$100 kΩ or 500 mV and 50 mV into 50 Ω. Repetition rate is 100 kHz or 1 kHz.

POWER REQUIREMENTS—Quick-change line-voltage taps permit operation from 90 to 110 V, 104 to 126 V, 112 to 136 V; or 180 to 220 V, 208 to 252 V, 224 to 272 V. Line frequency is 48 to 66 Hz. Power consumption is 210 watts maximum.

DIGITAL READOUT COMBINATIONS

Digital and analog displays are simultaneously presented on the Type 568 Readout Oscilloscope and Type 230 Digital Unit. A Digital Readout Combination consists of a Type 568, Type 230, and any of the following combinations of amplifier and time-base plug-in units. Units marked with asterisk are programmable in addition to providing digital readout. The Type 3A2 and 3B2 should be installed in pairs. Other 2-Series and 3-Series Plug-In Units can be used for normal analog CRT display, but do not provide digital readout.

PLUG-IN UNITS

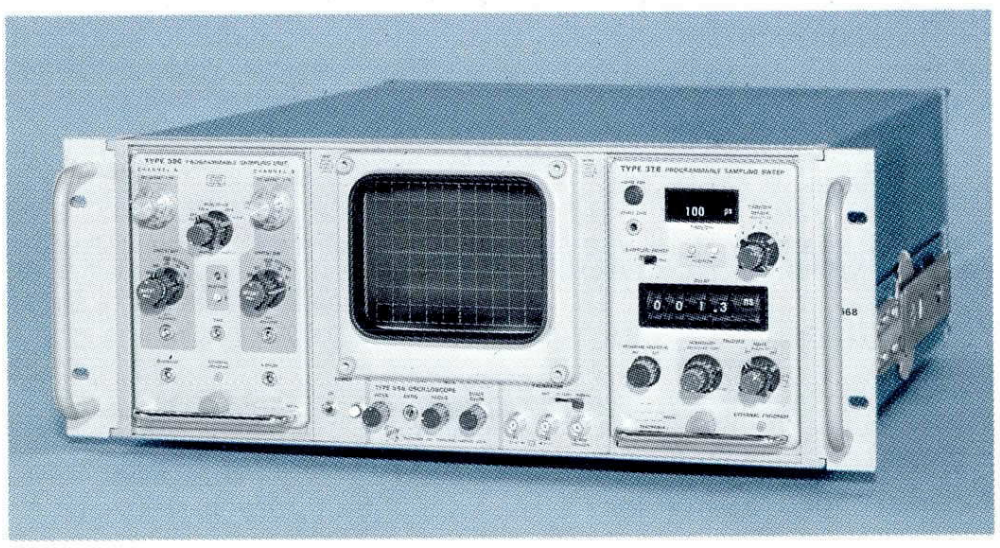
VERTICAL

TYPE	MINIMUM DEFLECTION FACTOR	T_R	BANDWIDTH	PRICE
3S1	2 mV/div	350 ps	DC to 1 GHz	$1350
3S2	2 mV/div	Use with S-Series Heads		950
3S5*	2 mV/div	Use with S-Series Heads		1700
3S6*	2 mV/div	Use with S-Series Heads		1700
S-1	50-Ω Head	350 ps	DC to 1 GHz	300
S-2	50-Ω Head	75 ps	DC to 4.5 GHz	355
S-3	100-kΩ Head	350 ps	DC to 1 GHz	435
S-4	50-Ω Head	25 ps	DC to 14 GHz	875
S-5	1 MΩ Head	1 ns	DC to 350 MHz	345
3A2	10 mV/div	700 ns	DC to 500 kHz	650

TIME BASE

TYPE	CALIBRATED SWEEP RANGE	PRICE
3T2	200 ps/div to 100 μs/div plus X10 magnifier	$1100
3T5*	100 ps/div to 500 ms/div	1800
3T6*	100 ps/div to 500 ms/div	1800
3T77A	200 ps/div to 100 μs/div plus X10 magnifier	800
3B2	2 μs/div to 1 s/div	795

*Programmable in addition to providing digital readout.



AMPLITUDE CALIBRATOR

Front-panel selection of squarewave outputs of 100 [illegible] crystal-controlled, with an accuracy of ±0.05% or app[illegible] 1 kHz, RC time-constant controlled. Output voltages are 5 V and 0.5 V into 100 kΩ or greater or 500 mV and 50 mV into 50 Ω. + PRETRIGGER output provides a positive-going pulse that occurs ≈¼ cycle ahead of the rising portion of the calibrator signal. Connectors are BNC.

TEKTRONIX CRT

5-inch rectangular CRT with 3.5-kV accelerating potential. A P2 phosphor is normally supplied; P7, P11, or P31 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability.

ILLUMINATED INTERNAL GRATICULE

Edge lighted graticule is marked in 8 vertical and 10 horizontal divisions (centimeters). Centerlines are also marked in 2-mm increments. Scale illumination is adjustable with a front-panel control.

DC-VOLTAGE SUPPLIES

Electronically regulated to compensate for widely varying line conditions. Separate regulated heater supply is included. The Type 568 has an additional 25 watts of regulated power available at the rear connector for system use.

POWER REQUIREMENTS

90 to 136 VAC or 180 to 272 VAC, 48 to 66 Hz, 210 watts maximum. Rear panel selector provides rapid accommodation for six line-voltage ranges.

TYPE 568 DIMENSIONS AND WEIGHTS

Height	8 in	20.3
Width	16 13/16 in	42.7 cm
Depth	21 7/8 in	55.5 cm
Net weight	40 lb	18.2 kg
Domestic shipping weight	≈52 lb	≈23.6 kg
Export-packed weight	≈72 lb	≈32.7 kg

TYPE R568 DIMENSIONS AND WEIGHTS

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Rack depth	22 3/4 in	57.8 cm
Net weight	41 lb	18.6 kg
Domestic shipping weight	≈56 lb	≈25.5 kg
Export-packed weight	≈76 lb	≈34.5 kg

INCLUDED STANDARD ACCESSORIES

3 to 2-wire adapter (103-0013-00); implosion shield (337-0539-00); 18-inch patch cord, BNC-to-BNC (012-0087-00); 18-inch patch cord, BNC-to-banana plug (012-0091-00); patch cord, post jack-to-BNC (012-0092-00); two instruction manuals (070-0596-00) Type R568 also includes mounting tracks (351-0086-00) and mounting hardware.

TYPE 568 OSCILLOSCOPE, without plug-in units . . $1025

TYPE R568 OSCILLOSCOPE, without plug-in units . $1075

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Programmable Sampling Amplifier

3S5

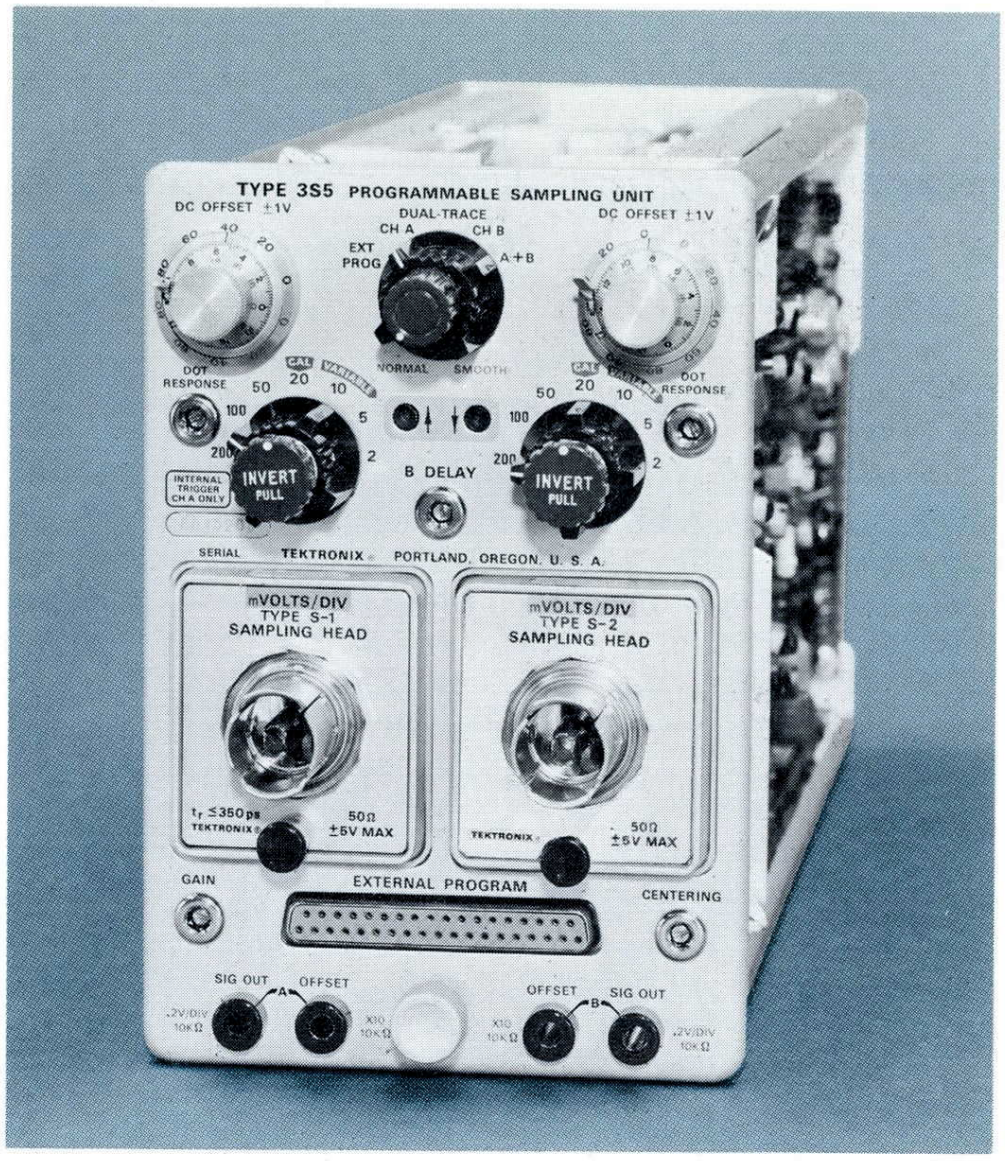
- ***PROGRAMMABLE VOLTS/DIV***
- ***PROGRAMMABLE DC OFFSET***
- ***PLUG-IN SAMPLING HEADS***
- ***FRONT AND REAR PANEL PROGRAM CONNECTORS***

The Type 3S5 can be used in the Type 561B and 564B Oscilloscopes, where it may be operated manually from the front panel or externally programmed.

The Type 3S5 Programmable Sampling Unit also extends the automated measurement capabilities of the Type 568 Digital Readout Oscilloscope by allowing remote programming of the vertical plug-in measurement functions.

The Type 3S5 is a dual-trace programmable vertical unit featuring Sampling Heads that plug-in directly or are located remotely with the optional Sampling-Head extenders. Most of the measurement functions of the Type 3S5 are externally programmable through use of parallel multi-pin connectors on the front panel of the plug-in and the rear panel of the Type 568 Oscilloscope. Programmable functions include deflection factor, DC offset and smoothing.

Sampling Heads feature a choice of measurement capabilities and may be mixed or matched to meet specific measurement needs. A front-panel control allows adjustment of the interchannel time relationship to compensate for signal cables or other external delays.



CHARACTERISTICS

SAMPLING HEADS

May be plugged into the Type 3S5 or located remotely on the optional 3-ft or 6-ft Sampling-Head extenders.

SAMPLING HEAD	RISETIME	INPUT	MINIMUM DEFLECTION FACTOR	DISPLAYED NOISE	PRICE
Type S-1	350 ps	50 Ω, GR874	2 mV/div	2 mV	$300
Type S-2	75 ps	50 Ω, GR874	2 mV/div	6 mV	$355
Type S-3	350 ps	100 kΩ, 2.3 pF	2 mV/div	3 mV	$435
Type S-4	25 ps	50 Ω, 3 mm	2 mV/div	5 mV	$875
Type S-5	1 ns	1 MΩ, 15 pF	2 mV/div	500 μV	$345

DEFLECTION FACTOR

2 mV/div to 200 mV/div in 7 calibrated steps, 1-2-5 sequence. Each step accurate within 3% in normal mode, within 4% smoothed. Vertical outputs to the Type 230, each channel programmed with 3 program lines or by manual front-panel controls.

DC OFFSET RANGE

+1 V to —1 V. Allows signals between +1-V and —1-V limits to be displayed at 2 mV/div. Continuously variable and calibrated with front-panel controls between +1 V and —1 V, accurate within 10 mV of same offset voltage obtained in the external program mode. Programmable between +995 mV and —995 mV in 5-mV steps. The programmable accuracy is within 2% or 5 mV (whichever is greater) of the programmed value. Programming is accomplished with 9 program lines per channel in modified BCD code plus one program line per channel for + or — polarity.

B-DELAY RANGE

Channel B display can be continuously positioned in time from +5 ns to —5 ns with respect to Channel A. Accommodates up to 3-foot difference in signal cable or Sampling-Head extenders.

PROGRAMMING

The Type 3S5 uses negative logic with true being ground or <2 V, and false being open or >6 V. The units/div range is programmed with 3 lines per channel. DC offset is programmed with 9 lines per channel in modified BCD code plus one line per channel for + or — polarity. One line is used to program smoothed or normal operation. A total of 27 program lines plus ground is required to externally program all the measurement functions of the Type 3S5.

DISPLAY MODES

A only, B only, dual trace, algebraic addition of A and B signals. In the external program mode, dual-trace operation is automatically provided. Independent controls for each channel permit positioning and inverting displays as desired.

WEIGHTS

Net weight	6¼ lb	2.8 kg
Domestic shipping weight	≈10 lb	≈4.5 kg
Export-packed weight	≈14 lb	≈6.3 kg

INCLUDED STANDARD ACCESSORIES

Connector (131-0422-00); connector cover (200-0660-00); circuit board connector (388-0805-00); two instruction manuals (070-0788-00).

TYPE 3S5 PROGRAMMABLE SAMPLING UNIT, without Sampling Heads **$1700**

OPTIONAL ACCESSORIES

3-ft Sampling-Head extender, order 012-0124-00 . . . . . $64

6-ft Sampling-Head extender, order 012-0125-00 . . . . . $66

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Programmable Sampling Amplifier

3S6

- ***PROGRAMMABLE VOLTS/DIV***
- ***PROGRAMMABLE DC OFFSET***
- ***REMOTE SAMPLING HEADS***
- ***ALL CONNECTIONS ON REAR PANEL***

The Type 3S6 Programmable Sampling Unit is designed for use only in the Type 568 and Type R568 Digital Readout Oscilloscopes. The measurement functions of the Type 3S6 may be operated manually from the front panel or they may be controlled externally from connectors mounted on the rear panel of the Type 568 Oscilloscope. The Type 3S6 is designed primarily for use in automated measurement systems that require minimum front panel connections and remote programming of all vertical measurement functions. The programmable functions of the Type 3S6 are deflection factor, DC offset, and smoothing. Sampling Heads and program cables are attached to rear panel connectors on the Type 568 Oscilloscope.

Sampling Heads feature a choice of measurement capabilities and may be mixed or matched to meet specific measurement needs. A front-panel control allows adjustment of the interchannel time relationship to compensate for signal cables or other external delays.

CHARACTERISTICS

SAMPLING HEADS

Located remotely on included 6-ft Sampling-Head extender that connects on the rear of the Type 568 Oscilloscope. Type 568 Oscilloscopes below serial number B110000 require a modification. Please consult your Field Engineer, Representative or Distributor.

SAMPLING HEAD	RISETIME	INPUT	MINIMUM DEFLECTION FACTOR	DISPLAYED NOISE	PRICE
Type S-1	350 ps	50 Ω, GR874	2 mV/div	2 mV	$300
Type S-2	75 ps	50 Ω, GR874	2 mV/div	6 mV	$355
Type S-3	350 ps	2.3 pF, 100 kΩ	2 mV/div	3 mV	$435
Type S-4	25 ps	50 Ω, 3 mm	2 mV/div	5 mV	$875
Type S-5	1 ns	1 MΩ, 15 pF	2 mV/div	500 μV	$345

DEFLECTION FACTOR

2 mV/div to 200 mV/div in 7 calibrated steps, 1-2-5 sequence. Each step accurate within 3% in normal mode, within 4% smoothed. Vertical outputs to the Type 230, each channel programmed with 3 program lines or by manual front-panel controls.

DC OFFSET RANGE

+1 V to −1 V. Allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. Continuously variable and calibrated with front-panel controls between +1 V and −1 V, accurate within 10 mV of same offset voltage obtained in the external program mode. Programmable between +995 mV and −995 mV in 5-mV steps. The programmable accuracy is within 2% or 5 mV (whichever is greater) of the programmed value. Programming is accomplished with 9 program lines per channel in modified BCD code, plus one program line per channel for + or − polarity.

B-DELAY RANGE

Channel B display can be continuously positioned in ti from +5 ns to −5 ns with respect to Channel A. Accom dates up to 3-foot difference in signal cables.

PROGRAMMING

The Type 3S6 uses negative logic with true being ground or <2 V and false being open or >6 V. The units/div range is programmed with 3 lines per channel. DC offset is programmed with 9 lines per channel in modified BCD code plus one line per channel for + or − polarity. One line is used to program smoothed or normal operation. A total of 27 program lines plus ground is required to externally program all the measurement functions of the Type 3S6.

DISPLAY MODES

A only, B only, dual trace, and algebraic addition of A and B signals. In the external program mode, dual-trace operation is automatically provided. Independent controls for each channel permit positioning and inverting displays as desired.

WEIGHTS

Net weight	6½ lb	3 kg
Domestic shipping weight	≈10 lb	≈4.5 kg
Export-packed weight	≈14 lb	≈6.3 kg

INCLUDED STANDARD ACCESSORIES

6-ft Sampling-Head extender (012-0130-00); two circuit board connectors (388-0805-00); two instruction manuals (070-0789-00).

TYPE 3S6 PROGRAMMABLE SAMPLING UNIT, without Sampling Heads **$1700**

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Sampling Heads

350-ps, 50-Ω INPUT

The Type S-1 is a 350-ps risetime, 1-GHz bandwidth unit with low random noise. Complete specifications on page 90.

TYPE S-1 SAMPLING HEAD $300

75-ps, 50-Ω INPUT

The Type S-2 is a 75-ps risetime, 4.5-GHz bandwidth unit. Complete specifications on page 90.

TYPE S-2 SAMPLING HEAD $355

350-ps, 100-kΩ INPUT

The Type S-3 is a 350-ps risetime, 1-GHz bandwidth unit with a sampling probe input for higher INPUT IMPEDANCE (100 kΩ, pF). Complete specifications on page 91.

TYPE S-3 SAMPLING HEAD $435

25-ps, 50-Ω INPUT

The Type S-4 is a 25-ps risetime, 14-GHz bandwidth unit. The 50-Ω input uses a 3-mm connector. Complete specifications on page 93.

TYPE S-4 SAMPLING HEAD $875

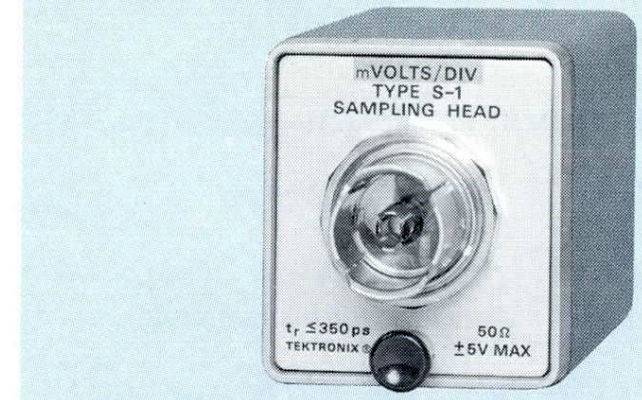
1-ns, 1-MΩ INPUT

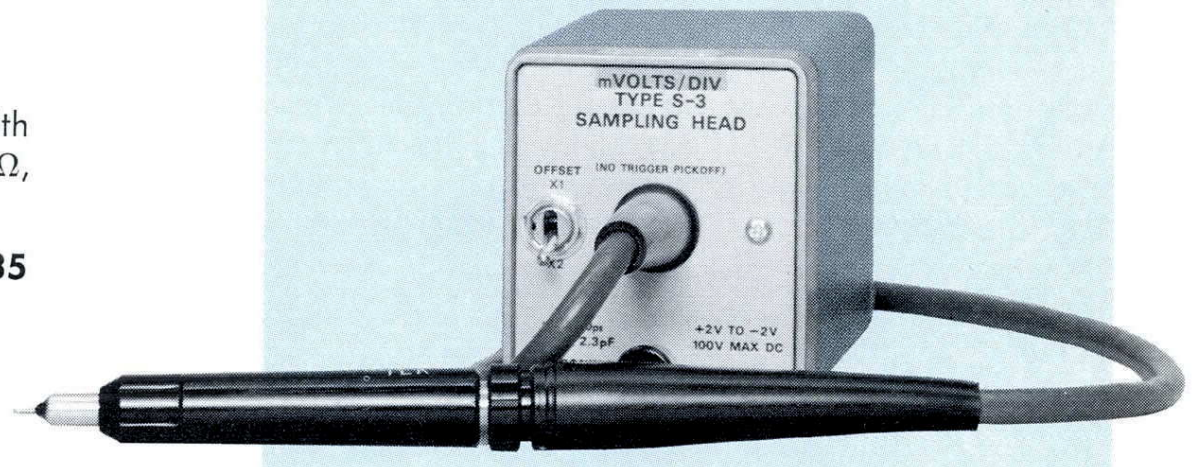
The Type S-5 is a 1-ns risetime, 350-MHz bandwidth unit. The input impedance is 1 MΩ, 15 pF and can be used with conventional passive probes. Complete specifications on page 92.

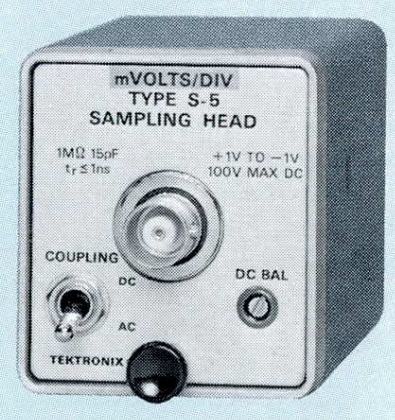
TYPE S-5 SAMPLING HEAD $345

For applications requiring up to 64 Sampling Heads, see Type 286, 287 and R288 Multiplexers. Complete specifications on ges 250-255.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.







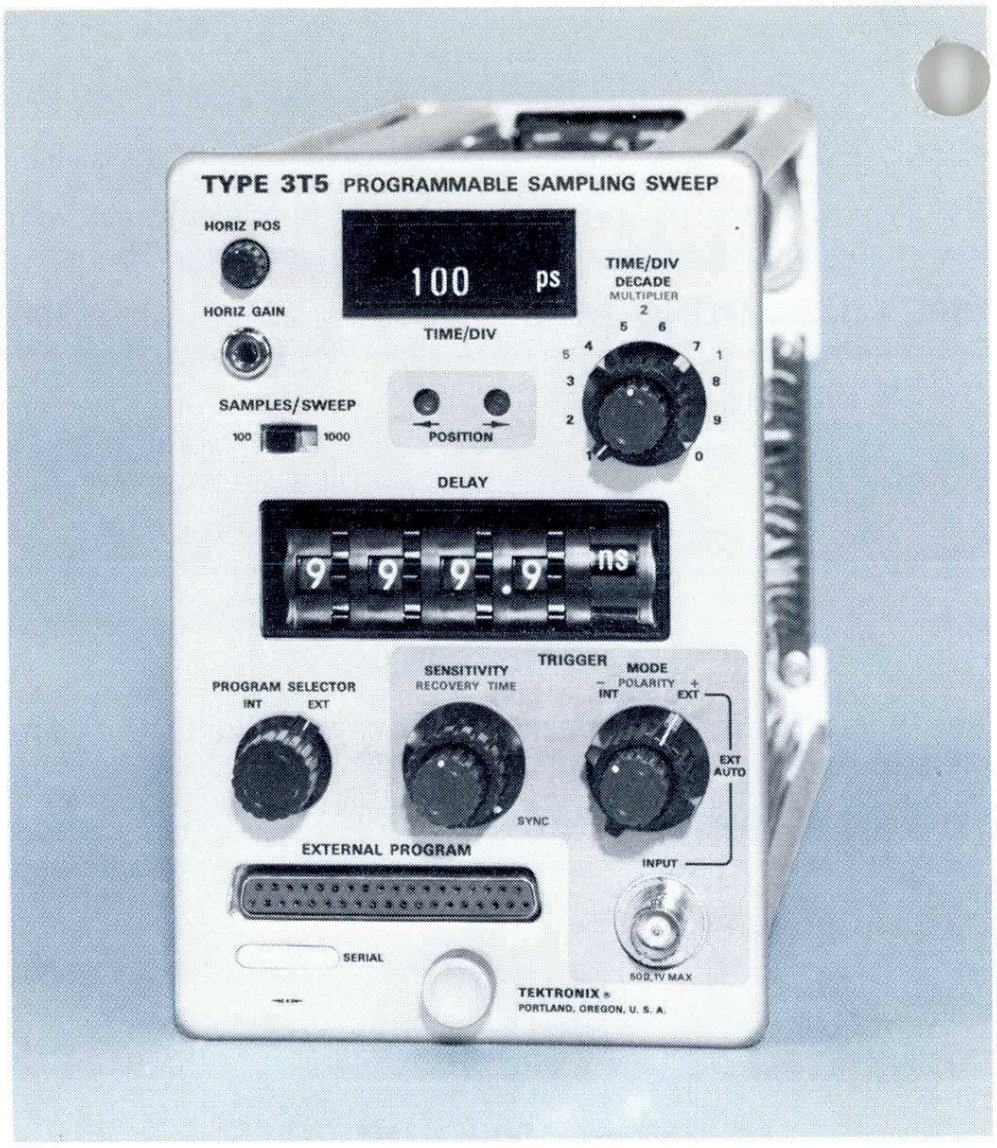
Programmable Sampling Sweep

3T5

- ***PROGRAMMABLE TIME/DIV***
- ***PROGRAMMABLE SWEEP DELAY***
- ***100 ps/DIV-to-500 ms/DIV CALIBRATED SWEEP RANGE***
- ***FRONT AND REAR PANEL PROGRAM CONNECTORS***

The Type 3T5 Programmable Sampling Sweep Unit extends the automatic measurement capabilities of the Type 568 Digital Readout Oscilloscopes, by allowing remote programming of the sampling sweep unit. The Type 3T5 can also be used in the Type 561B and Type 564B Oscilloscopes where it may be operated manually from the front panel, or externally programmed with the front panel program connector.

The time/div range, delay time range and samples/sweep of the Type 3T5 are externally programmed by means of parallel multipin connectors located on the front panel of the Type 3T5 and the rear panel of the Type 568 Oscilloscope (Serial Number B110000 and above). Digital delay and real-time sampling (1 ms/div to 500 ms/div) are controlled by a clock and digital counter within the plug-in unit. An automatic trigger mode is provided to eliminate the need for trigger adjustments over a wide range of trigger amplitudes, repetition rates, risetimes and pulse widths.



CHARACTERISTICS

SWEEP TIME/DIV

Remotely programmable or front-panel operation from 100 ps/div to 500 ms/div in 30 calibrated steps, 1-2-5 sequence. TIME/DIV "window" provides digital readout of all sweep time/div settings in both programmable and manual modes of operation. Programming is accomplished with 7 program lines. Accuracy is within 3% (within 5% from 100 ps/div to 500 ps/div), except for non-linearities at the beginning of the sweep, that can be programmed off screen.

SAMPLES/SWEEP

100 samples/sweep or 1000 samples/sweep are available in both the manual and external programming modes of operation. In the external program modes, the Type 230 Digital Unit can program the sweep unit to scan quickly (100 samples/sweep) when not making a measurement, but provides maximum measurement resolution (1000 samples/sweep) when making the measurement.

DELAY RANGE

The digital delay is remotely programmable or selectable from the front panel. The delay range is from 0 to 999.9 ns in 100-ps increments from 100 ps/div to 500 ps/div; 0 to 9.999 μs in 1-ns increments from 1 ns/div to 1 μs/div; 0 to 999.9 μs in 100-ns increments from 2 μs/div to 500 μs/div. Programming is accomplished with 16 program lines.

DELAY JITTER (All Sweep Speeds)

$\leq$0.1 div, independent of the amount of delay.

TRIGGERING

SOURCES: Internal, if sampling unit contains a trigger pick-off; External, 50-Ω terminated input.

JITTER: External automatic, pulse, 30 ps or less with 300-mV pulse, 2 ns or less wide; sinewave, 200 ps or less with 300-mV P-P signal at 30 MHz.

PULSE TRIGGERING		
SOURCE	FREQUENCY	AMPLITUDE
Internal	DC to 100 MHz	100 mV to 2 V
External	DC to 100 MHz	5 mV to 250 mV
External Automatic	DC to 100 MHz	100 mV to 500 mV
SINEWAVE TRIGGERING		
SOURCE	FREQUENCY	AMPLITUDE peak-to-peak
Internal	100 kHz to 100 MHz	100 mV to 2 V
External	1 Hz to 100 MHz	10 mV to 500 mV
External Sync	100 MHz to 1 GHz	10 mV to 150 mV
External Automatic	DC to 100 MHz	100 mV to 500 mV

WEIGHTS

Net weight	7 lb	3.2 kg
Domestic shipping weight	$\approx$10 lb	$\approx$4.5 kg
Export-packed weight	$\approx$14 lb	$\approx$6.3 kg

INCLUDED STANDARD ACCESSORIES

5-ns, 50-Ω RG58 cable with BNC connectors (012-0057-01); 10X 50-Ω BNC attenuator (011-0059-01); GR-to-BNC female adapter (017-0063-00); GR-to-BNC male adapter (017-0064-00); electrical connector (131-0422-00); electrical connector cover (200-0660-00); circuit board connector (388-0805-00); two instruction manuals (070-0760-00).

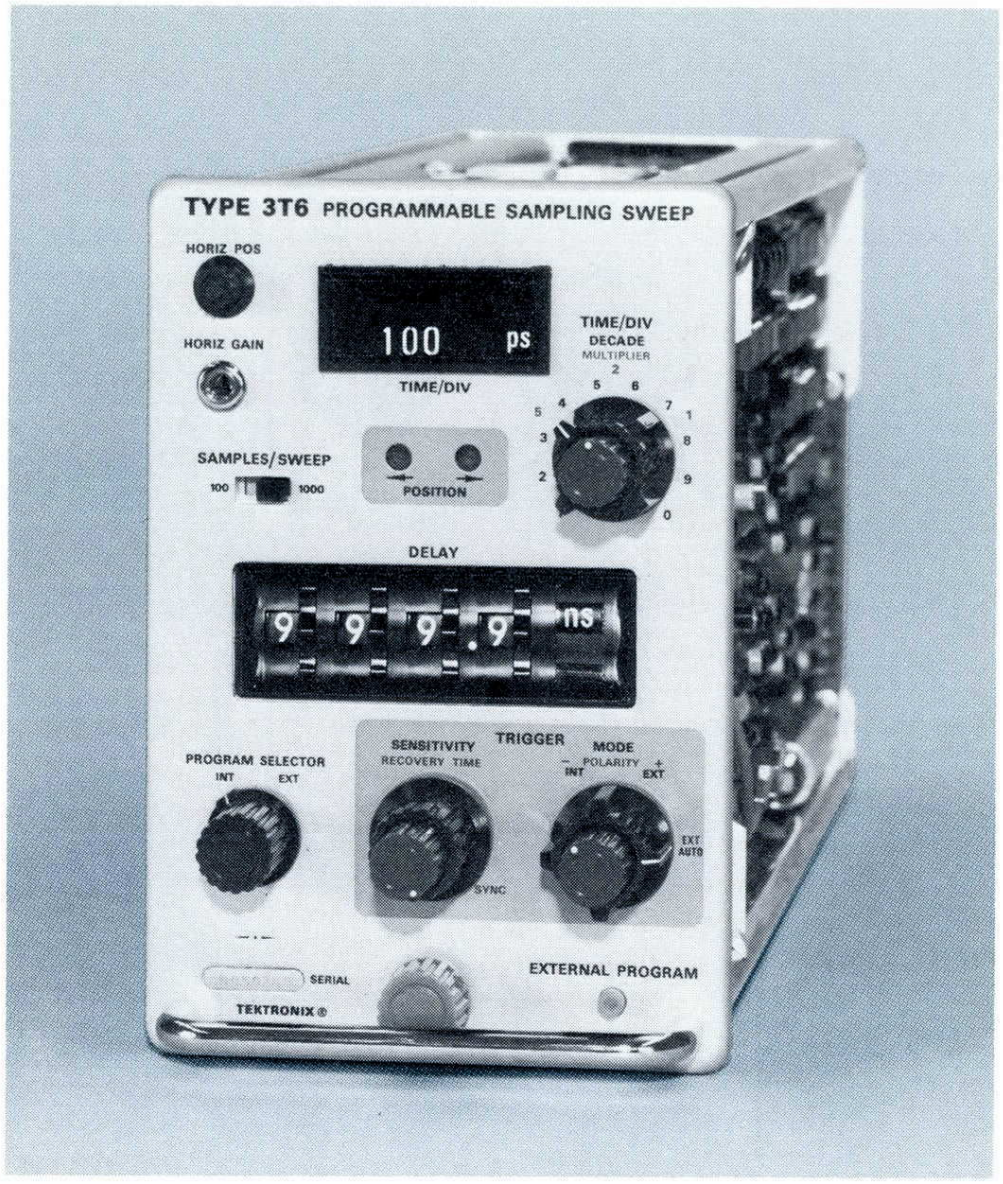
TYPE 3T5 SAMPLING UNIT **$18**

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Programmable Sampling Sweep

3T6

- ***PROGRAMMABLE TIME/DIV***
- ***PROGRAMMABLE SWEEP DELAY***
- ***100 ps/DIV to 500 ms/DIV CALIBRATED SWEEP RANGE***
- ***ALL CONNECTIONS ON REAR PANEL***



The Type 3T6 Programmable Sampling Sweep Unit is designed for use only in the Type 568 and Type R568 Digital Readout Oscilloscopes. The measurement functions of the Type 3T6 may be operated manually from the front panel or they may be controlled externally from connectors mounted on the rear panel of the Type 568 Oscilloscope. The Type 3T6 is designed for use in automated measurement systems that require minimum front panel connections and remote programming of horizontal functions.

The time/div range, sweep delay range and sample per sweep of the Type 3T6 are externally programmable using negative logic, with true being ground and false being open. Digital sweep delay and real-time sampling (1 ms/div to 500 ms/div) are controlled by a clock and digital counter within the plug-in unit. An automatic trigger mode is provided to eliminate the need for trigger circuit adjustment over a wide range of pulse amplitudes, repetition rates, and pulse waveshapes. Type 568 Oscilloscopes below the serial number B11-[illegible]0 require a modification for use with the Type 3T6. Please consult your Field Engineer, Representative, or Distributor.

CHARACTERISTICS

SWEEP TIME/DIV

Remotely programmable or front panel operation from 100 ps/div to 500 ms/div in 30 calibrated steps, 1-2-5 sequence. TIME/DIV "window" provides digital readout of all sweep time/div settings in both programmable and manual modes of operation. Programming is accomplished with 7 program lines. Accuracy is within 3% (within 5% from 100 ps/div to 500 ps/div), except for non-linearities at the beginning of the sweep, that can be programmed off screen.

SAMPLES/SWEEP

100 samples/sweep or 1000 samples/sweep are available in both the manual and external programming modes of operation. In the external program modes, the Type 230 Digital Unit can program the sweep unit to scan quickly (100 samples/sweep) when not making a measurement, but provides maximum measurement resolution (1000 samples/sweep) when making the measurement.

DELAY RANGE

The digital delay is remotely programmable or selectable from the front panel. The delay range is from 0 to 999.9 ns in 100-ps increments from 100 ps/div to 500 ps/div; 0 to 9.999 μs in 1-ns increments from 1 ns/div to 1 μs/div; 0 to 999.9 μs in 100-ns increments from 2 μs/div to 500 μs/div. Programming is accomplished with 16 program lines.

DELAY JITTER (All Sweep Speeds)

$\leq$0.1 div, independent of the amount of delay.

TRIGGERING

SOURCES: Internal, if sampling unit contains a trigger pickoff; External, 50-Ω terminated input.

JITTER: External automatic, pulse, 30 ps or less with 300-mV pulse, 2 ns or less wide; sinewave, 200 ps or less with 300-mV P-P signal at 30 MHz.

PULSE TRIGGERING		
SOURCE	FREQUENCY	AMPLITUDE
Internal	DC to 100 MHz	100 mV to 2 V
External	DC to 100 MHz	5 mV to 250 mV
External Automatic	DC to 100 MHz	100 mV to 500 mV

SINEWAVE TRIGGERING		
SOURCE	FREQUENCY	AMPLITUDE peak to peak
Internal	100 kHz to 100 MHz	100 mV to 2 V
External	1 Hz to 100 MHz	10 mV to 500 mV
External Sync	100 MHz to 1 GHz	10 mV to 150 mV
External Automatic	DC to 100 MHz	100 mV to 500 mV

WEIGHTS

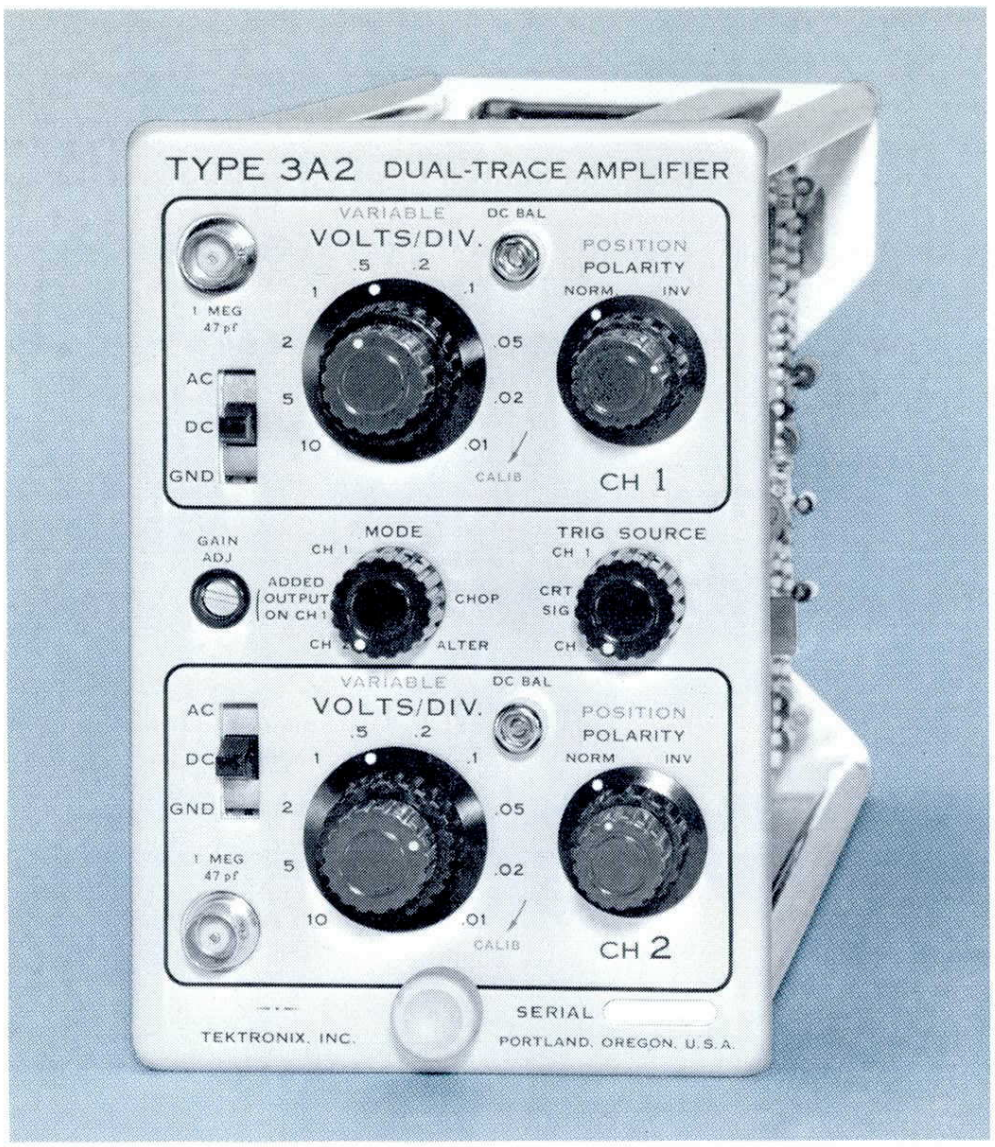
Net weight	7 lb	3.2 kg
Domestic shipping weight	$\approx$10 lb	$\approx$4.5 kg
Export-packed weight	$\approx$14 lb	$\approx$6.3 kg

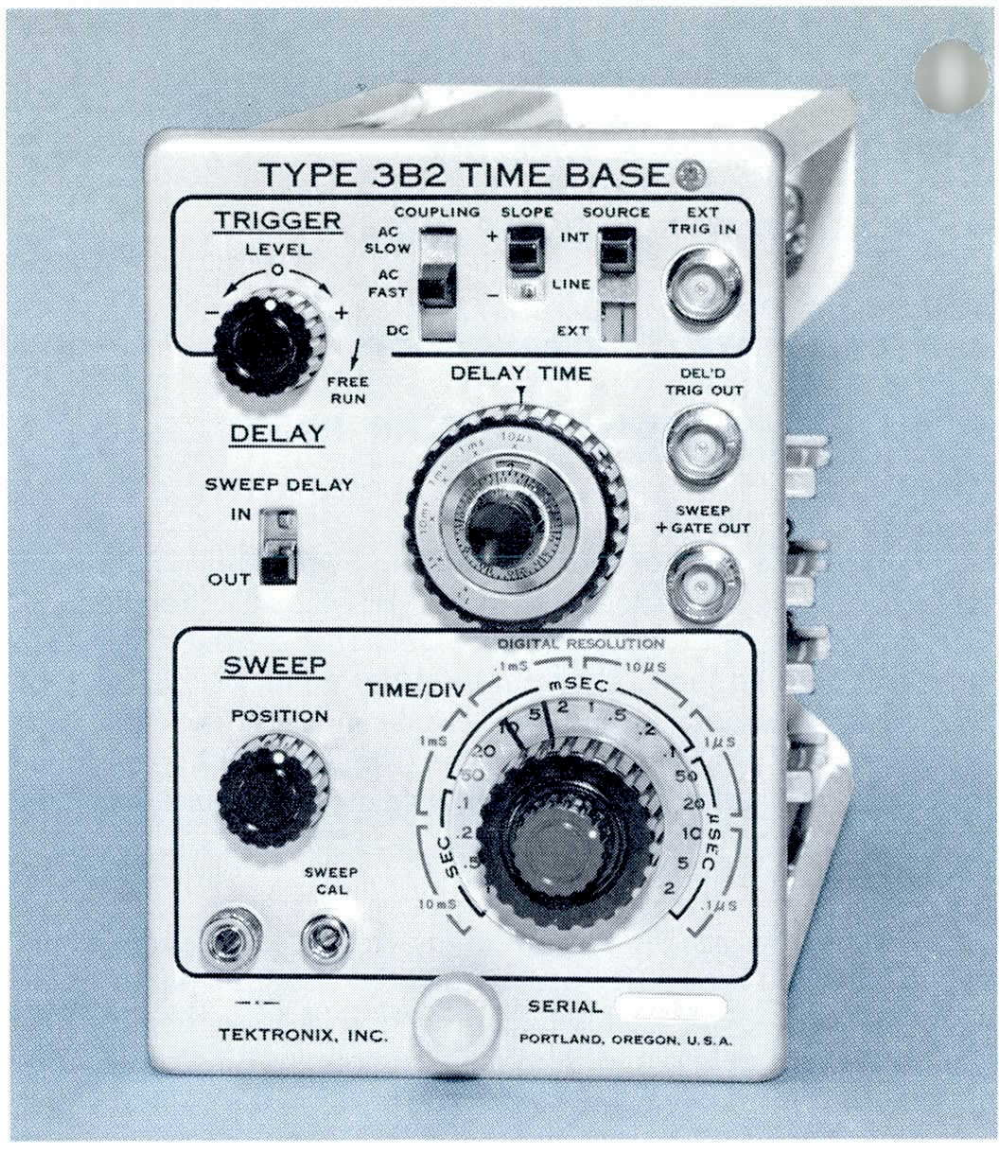
INCLUDED STANDARD ACCESSORIES

Circuit board connector (388-0805-00); two instruction manuals (070-0761-00).

TYPE 3T6 SAMPLING SWEEP UNIT $1800

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.





The Type 3A2 Dual-Trace Amplifier and Type 3B2 Time-Base Units enable digital readout and analog displays of low and medium-frequency information. Both types of displays are provided using the Type 568 Oscilloscope (with Type 230). Analog displays (but not digital readout) are provided using Type 561B or 564B Oscilloscopes. The Type 3A2 also provides analog displays in the Type 565 Oscilloscope.

TYPE 3A2 DUAL-TRACE AMPLIFIER UNIT

BANDWIDTH
DC to 500 kHz at 3-dB down. Low-frequency 3-dB point AC-coupled: 2 Hz.

DEFLECTION FACTOR
10 mV/div to 10 V/div in 10 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div.

INPUT RC
1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE
600 V (DC + peak AC).

OPERATING MODES
Either single channel, normal or inverted; algebraic addition; chopped or alternate electronic switching between channels. Alternate: channels switched at the end of each sweep. Chopped: successive 12-μs segments of each channel displayed at an approx 40-kHz rate per channel. Chopped transient blanking is provided.

TRIGGER SOURCE
Channel 1, Channel 2, or displayed signal.

TYPE 3A2 DUAL-TRACE AMPLIFIER UNIT $650

TYPE 3B2 TIME-BASE UNIT

TIME BASE
2 μs/div to 1 s/div in 18 calibrated steps (1-2-5 sequence), accurate within 3%. Calibrated digital readout available throughout full time base with Types 568 and 230.

DIGITAL RESOLUTION
0.1 μs to 10 ms in 6 decade steps with Types 568 and 230. Resolution can be selected independently of time/div, to increase digital readout accuracy when the first significant digit is known. Front panel indicates maximum resolution (without possible counter overflow) that can be attained for each time/div setting. Clock accuracy is 0.1%.

DELAY TIME
5 μs to 10.5 s, continuously variable and calibrated, accurate within 1%. Delay can be switched in or out.

SIGNAL OUTPUTS
Delayed trigger nominally +5 V, sweep gate nominally +15 V.

TRIGGER COUPLING
AC Slow, AC Fast, or DC.

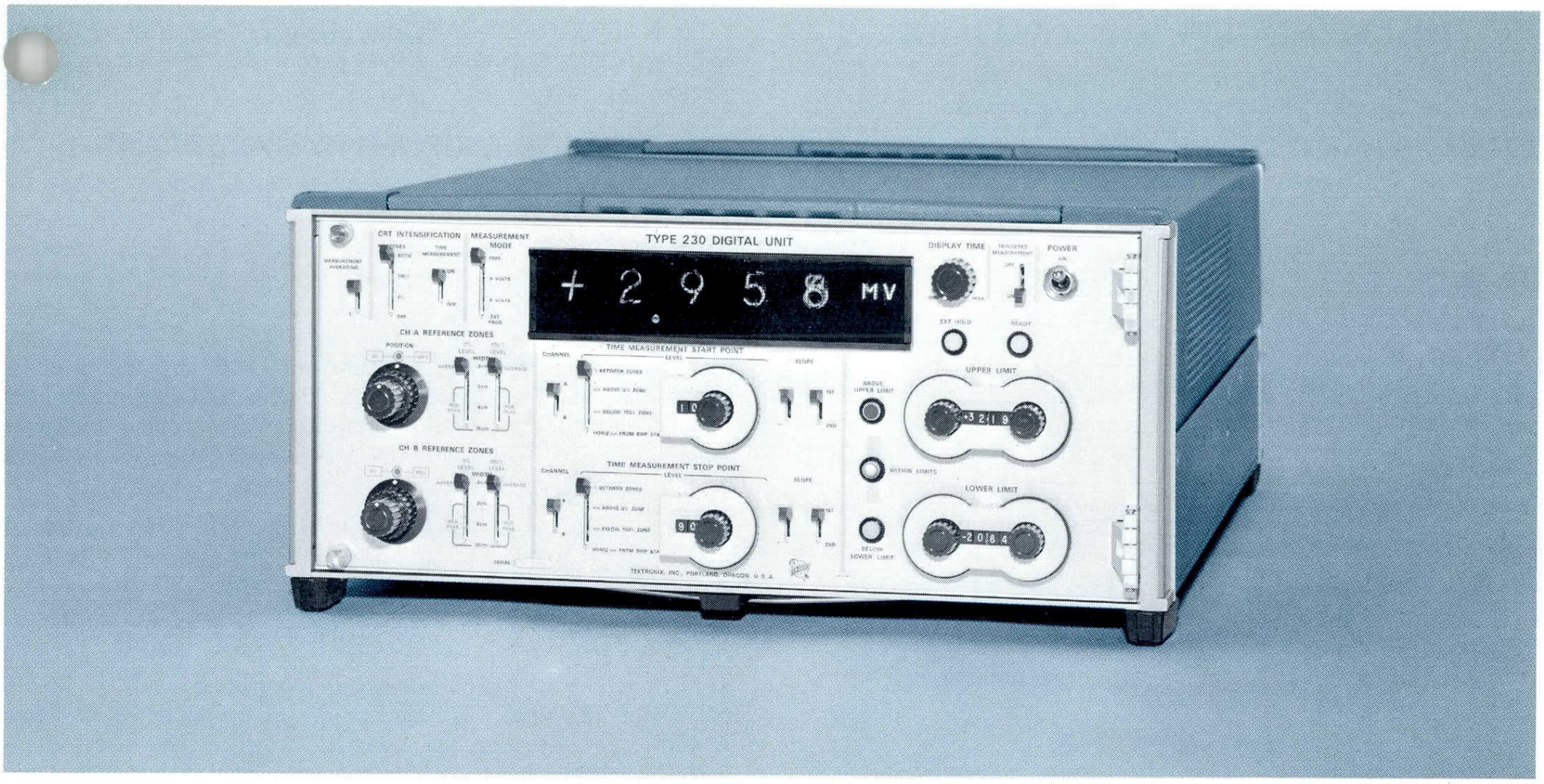
TRIGGER SOURCES
Internal, external, or line.

TRIGGER REQUIREMENTS
0.2-cm deflection or 0.4 V external. ±12-V trigger level selection.

TYPE 3B2 TIME-BASE UNIT $795

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

230 Digital Unit R230



- ***PRESENTS OSCILLOSCOPE MEASUREMENTS IN DIGITAL FORM***
- ***DIGITAL READOUT PARAMETERS***

  PULSE AMPLITUDE
  PULSE RISE AND FALL TIME
  PULSE WIDTH
  TIME INTERVAL

- ***UP TO 100 MEASUREMENTS PER SECOND WITH OPTIONAL PROGRAMMERS***
- ***PARALLEL GROUND-CLOSURE PROGRAMMING***
- ***BCD DATA OUTPUT (1 2 4 8)***
- ***ALL SOLID STATE—EXTENSIVE USE OF INTEGRATED CIRCUITS***

The Type 230 and Type R230 Digital Units provide digital measurements of signals displayed on the Type 568 Oscilloscope. The Type 230 has flexible measurement capabilities with up to 100 measurements per second, easy programming, BCD data outputs, and solid-state circuitry with extensive use of integrated circuits. The Type 230 Digital Unit can make a wide variety of repetitive pulse measurements on the signals displayed on the Type 568. The digital presentations can designate voltage measurements, time-difference measurements between similar pulses, and time-difference measurements between voltages or percentages of pulse amplitudes. The Type [illegible] can be externally programmed for use in high-speed automatic measurement systems. Data output connectors provide measurement results in convenient BCD code. Programming is easily accomplished with the use of new Tektronix Program Units.

MEASUREMENT MODES

The Type 230 Digital Unit's four basic measurement functions (Channel A volts, Channel B volts, Time, and External Program) are selected by the Measurement Mode switch.

VOLTAGE measurements are made on either Channel A or Channel B between the 0% and the 100% reference zones. The signal polarity is determined and read out automatically on the digital readout.

TIME measurements are made on either Channel A, Channel B or between the two channels. The time measurements are made from a pre-determined start point to a pre-determined stop point that can be referenced to the 0% and 100% reference zones or to the start of the sweep.

EXTERNAL PROGRAM: All of the front-panel functions required to make voltage and time measurements can be easily programmed externally. The variety and flexibility of measurements possible with external programming are even greater than those possible through use of the Type 230 front-panel controls, and measurements and limits can be changed more rapidly.

DIGITAL READOUT

The measurements made by the Type 230 are read out directly on six Nixie* tubes. Decimal point and unit of measure (ns, μs, ms, s, mV, V) are automatically presented. The polarity of the measurement (+ or —) is also read out automatically.

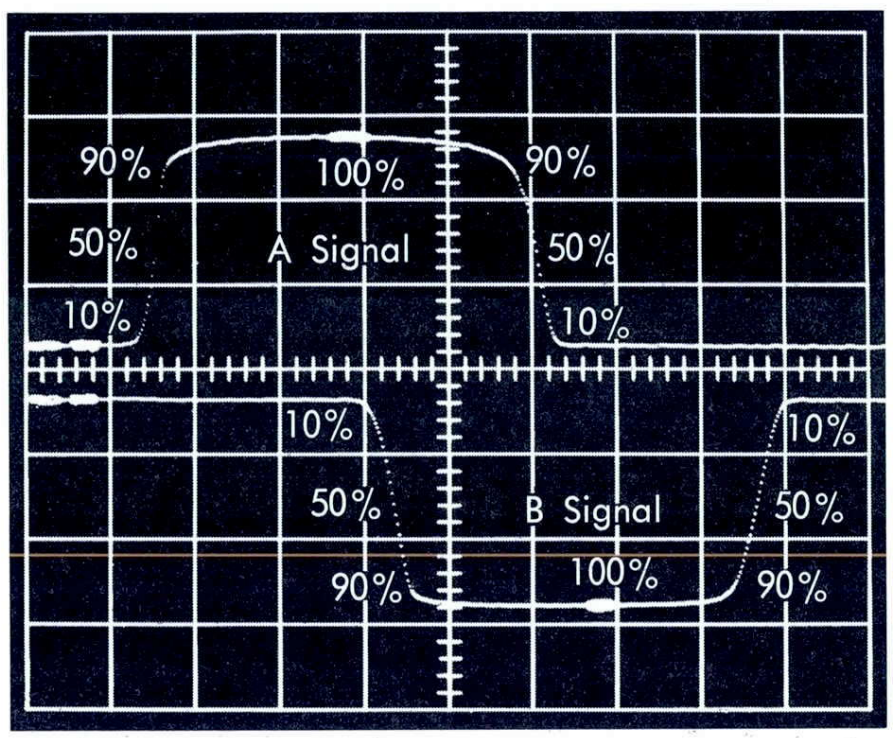
DISPLAY TIME

The digital readout display time may be varied from ≈10 ms to 10 s. EXTERNAL HOLD light indicates when the measured data is being held until the recording device has had sufficient time to record the measurement. External hold does not prevent the next measurement from being made. In TRIGGERED MEASUREMENT operation, a measurement is started after a receipt of a trigger (+ or —) and after DISPLAY TIME has been completed. The READY light indicates a ready condition for a trigger.

*Trade-Mark Burroughs Corporation

TYPICAL MEASUREMENT CAPABILITIES

DUAL-TRACE DISPLAY SHOWING TYPICAL MEASUREMENTS		
MEASUREMENT	PROGRAM	
	Start	Stop
Risetime A	+10%A	+90%A
Falltime A	−90%A	−10%A
Risetime B	−10%B	−90%B
Falltime B	+90%B	+10%B
Delay A to B	+10%A	−10%B
Storage A to B	−90%A	+90%B
Turn on A to B	+10%A	−90%B
Turn off A to B	−90%A	+10%B
Width A	+50%A	−50%A
Width B	−50%B	+50%B



REFERENCE ZONES

To make any digital voltage or time measurement of the waveforms displayed on the Type 568 Oscilloscope, the Reference Zones must be properly set. The 0% and the 100% zones establish the reference points from which all measurements are made. The reference zones can be brightened on the oscilloscope by means of the CRT Intensification Reference Zone switch. The switch brightens both zones, 100% zone only, 0% zone only or disables the zone intensification.

CHANNEL A REFERENCE ZONE

The 0% POSITION and 100% POSITION controls determine the start position of the 0% and 100% zones to any ½-cm point from the start of the sweep by means of a 20-position switch. Five external program lines are required for each position control.

LEVEL WIDTH controls select the width of the reference zone and select the type of voltage reading, average or peak.

The AVERAGE 0.3-cm WIDTH position of the control is normally used for average voltage and most time measurements.

The three PEAK positions (2-cm, 4-cm, 10-cm WIDTH) are used for average to peak, or peak to peak voltage measurements. Two program lines are required for each 0% LEVEL or 100% LEVEL width controls.

CH B REFERENCE ZONES are identical in function and operation as Ch A Reference Zones except they are set on Ch B display.

TIME MEASUREMENT START POINT

The start of the time measurement is selected to start on either Channel A or Channel B and on the first or second positive-going or negative-going slope. The time measurement starts when the signal reaches one of the 99 pre-determined levels. Four different modes of start point level selection are available: (1) % between 0% and 100% zones, (2) mm above 0% zone, (3) mm below 100% zone, and (4) Horizontal mm from sweep start. Eleven BCD program lines are required for externally programming the time measurement start point. There are 159 pre-determined levels available in the external programming mode.

CRT intensification during the time measurement portion of the sweep is selected by means of the CRT Intensification Time Measurement On-Off switch.

TIME MEASUREMENT STOP POINT

All functions of the Time Measurement Stop Point are identical to the previously explained Time Measurement Start Point. It stops the count on the selected point on Ch A or Ch B. If the Stop Point occurs before the Start Point, a negative reading is indicated.

LIMIT CONTROLS

The Limit Controls select the UPPER and LOWER measurement Limits. Measurement limit results can be quickly determined on the front-panel by means of three lights (ABOVE UPPER LIMIT, WITHIN LIMITS, BELOW LOWER LIMIT) and the information is available on the rear panel for stopping automatic measurement sequences or for automatic sorting. Fifteen BCD lines are required for programming each limit control.

RESOLUTION

DOTS/MEASUREMENT Time measurements are performed by gating and counting clock-pulses during the measurement interval. If a measurement interval occupied 2.5 div and the sweep speed was 10 ns/div with 100 samples/div, then 250 samples would be registered in the digital readout counter and reading would be 25.0-ns. For sweep speeds with multipliers of 2, the count is doubled and the decimal is shifted to maintain maximum resolution. For multiples of 5 the count is divided by 2 providing 50 samples/div.

The TIME MEASUREMENT START and STOP comparators have ±0.1 mm pick-off resolution capabilities. This gives the Type 230 the ability to scale a 1-cm display in 1% steps.

MEASUREMENT AVERAGING permits selection of measurements to be a statistical average of eight sweeps or to be a measurement of only one sweep. One program line is required for Measurement Averaging selection.

EXTERNAL READOUT

Data outputs are available on the rear-panel of the Type 230 that permit the recording of measurement polarity, displayed digits, units of measure, decimal point, and measurement limit results. The information is in BCD code (1 2 4 8; true . . . ground, false . . . +12 Volts) and the Type 230 can be synchronized to the data recorder.

Regulated power is available for use in systems applications.

230 Digital Unit R230

EXTERNAL PROGRAMMING

The Type 230 Digital Unit is designed to be externally programmed for use in high-speed measurement systems, up to 100 measurements per second with proper programming techniques. All of its measurement functions can be programmed by means of ground closures or logic levels. The programming is achieved with 105 program lines using negative logic with true being ground or <2 V and false being open or >6 V. Suitable programming devices include card readers, block readers, computers, etc.

HIGH SPEED PROGRAMMED MEASUREMENTS

When using the Type 3T5 or 3T6 Programmable Sampling Sweep Units for the oscilloscope time base, the Type 230 Digital Unit can program the sweep to provide increased measurement speeds. The time base can be made to run fast (10 dots/div) during the non-measurement part of the sweep and then run at normal speeds (100 dots/div) for maximum resolution during the measurement. This function is obtained by externally programming the high speed program line.

Measurement speed can be increased by externally programming the position of the 0% and/or 100% Reference Zones start point to 12 cm. This puts the reference zones into a memory hold position of up to 10 seconds and permits several different measurements to be made without a zone charging sweep. This gives an additional feature of permitting measurements referenced to reference zones that are not on the CRT display.

OTHER CHARACTERISTICS

POWER REQUIREMENTS

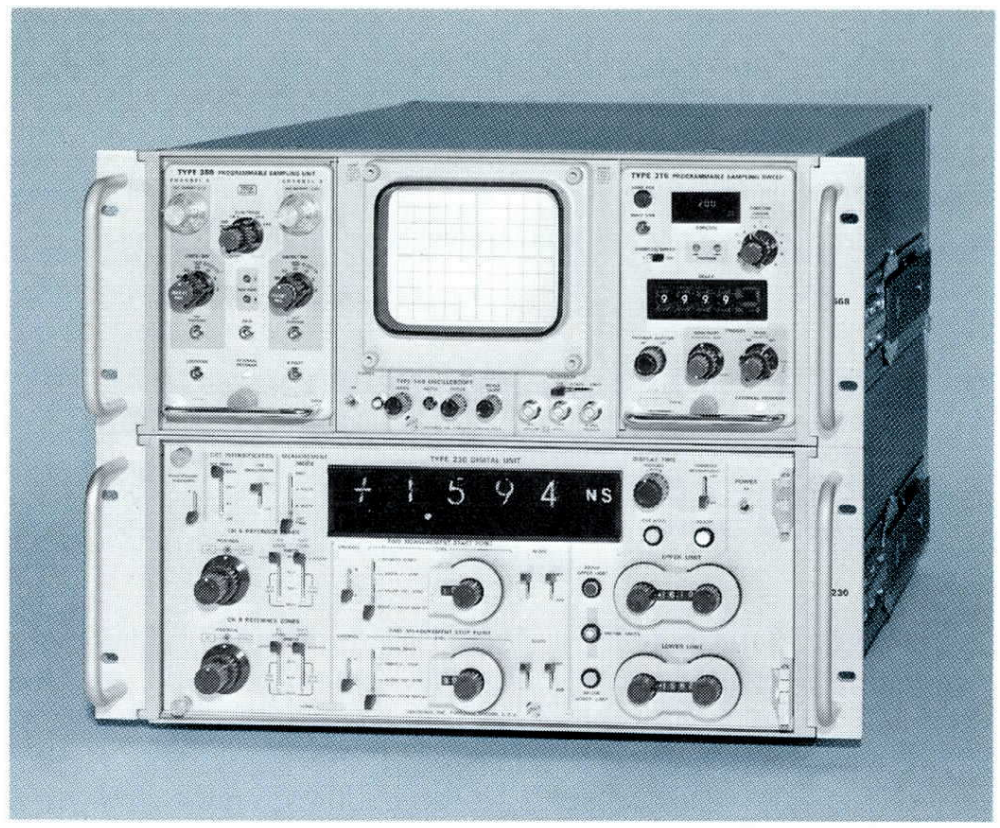
90 to 136 VAC or 180 to 272 VAC, 48 to 66 Hz, 130 watts maximum at 115 V and 60 Hz. Rear panel selector provides rapid accommodations for six line-voltage ranges.

TYPE 230 DIMENSIONS AND WEIGHTS

Height	8 in	20.3 cm
Width	$16\frac{13}{16}$ in	42.7 cm
Depth	$21\frac{7}{8}$ in	55.5 cm
Net weight	38 lb	17.3 kg
Domestic shipping weight	≈50 lb	≈22.7 kg
Export-packed weight	≈73 lb	≈33.2 kg

TYPE R230 DIMENSIONS AND WEIGHTS

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Depth	$22\frac{3}{4}$ in	57.8 cm
Net weight	40 lb	18.2 kg
Domestic shipping weight	≈52 lb	≈23.6 kg
Export-packed weight	≈75 lb	≈34.1 kg



INCLUDED STANDARD ACCESSORIES

Type 230 to Type 568 48-inch interconnecting cable (012-0119-01); 3 to 2-wire adapter (103-0013-00); two instruction manuals (070-0635-00). Type R230 also includes mounting tracks (351-0086-00) and mounting hardware.

TYPE 230 DIGITAL UNIT **$3520**

TYPE R230 DIGITAL UNIT **$3570**

PROBE CHOPPERS

Probe choppers are available for the P6045 Probe or the S-3 Sampling Probe. With the probe choppers, the Type 230 Digital Unit can make DC and pulse voltage measurements with respect to ground.

Probe Chopper Quad (set of 4) for S-3 Probes, includes case and accessories, order 015-0155-01 ..... $375

Probe Chopper for two S-3 Probes, order 015-0128-01 ... $190
Includes: two 10X attenuators (010-0367-00)

Probe Chopper for two P6045 Probes, order 015-0129-01 .. $110

Conversion Kit 230 to R230, order 040-0489-00 ..... $ 84
Includes all hardware required to convert bench Type 230 to rackmount R230.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

240 Program Control Unit R240

- ***CONTROLS TYPE 568 OSCILLOSCOPE AND TYPE 230 DIGITAL UNIT***
- ***PROGRAM BRANCHING FOR DIAGNOSTIC TESTING***
- ***SERIAL TO PARALLEL CONVERTOR***
- ***PROGRAM PREPARATION, MODIFICATION AND VERIFICATION***
- ***PROGRAM STORAGE***
  Disc Memory Option
  Punched Tape Reader Option
- ***FIXED WORD LENGTH***
  48 4-bit Characters
- ***EXPANDABLE WITH TYPE 250***
  192 or 384 Additional Program Lines

The Type 240 and Type R240 Program Control Units are designed to provide automated measurements utilizing the Type 568 Oscilloscope with the Type 3T5 or 3T6 and 3S5 or 3S6 Programmable Plug-In Units and the Type 230 Digital Unit. The Type 240 accepts program data serial-by-bit from the optional Disc Memory, serial-by-character from an optional Punched Tape Reader or from an external source. Programs may be originated or modified manually from the front panel of the Type 240. If other equipment needs to be externally programmed, a Type R250 Auxiliary Program Unit may be added to the Type 240.

Measurement rates in excess of 100 measurements per second are achieved using a Disc Memory. Sorting, classifying and diagnostic test routines are obtained using the Disc Memory. The Disc Memory also permits random access to a library of up to 1600 independent measurements. This feature permits a computer or other control device to have complete control over the test measurements, making calculations from the test data and using the Disc Memory for further measurements and sorting at the maximum test rates.

The Punched Tape Reader provides a maximum measurement rate of 5 measurements per second and is used in low-speed measurement systems. The Disc Memory can be added later to achieve maximum measurement rates and a library of 1600 measurement programs. The Punched Tape Reader is also used for loading measurement programs into the Disc Memory. The Type 240 may be used without the Disc Memory or Punched Tape Reader by providing program data externally in a serial-by-character form, asynchronously at up to 600-kHz character rate. Data sources include paper or magnetic Tape Readers and computer data output.

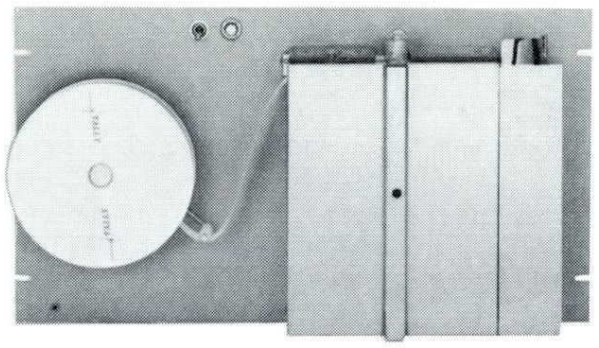
The Type 240 has a fixed word length of 48 4-bit characters that normally are used to program the measurement address, Type 568 Oscilloscope with the Type 3T5 or 3T6 and 3S5 or 3S6 Programmable Plug-In Units, and the Type 230 Digital Unit. The 192 program lines use negative logic, with true being a saturated NPN transistor to ground and false being an open collector. The Type 240 Program can also be used to program other equipment.

The Type R250 Auxiliary Program Unit expands the programming capabilities of the Type 240, permitting programming of pulse generators, power supplies, test fixtures, automatic handlers, and other devices required for automated measurement systems. The Type R250 provides program buffering, digital-to-analog conversion and patch panel capabilities. One Type R250 provides an additional 192 program lines; two Type R250's provide 384 program lines.

DATA RECORDING

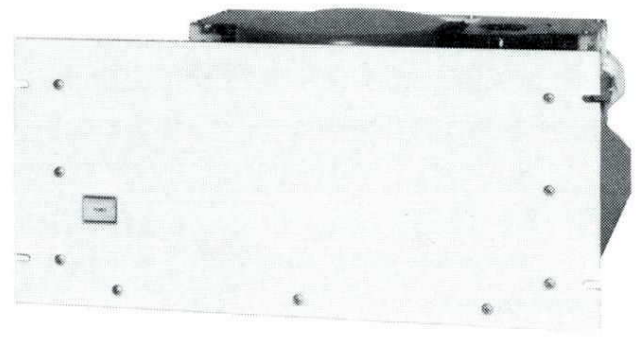
TYPE 568/230 DIGITAL OSCILLOSCOPE

- Voltage Measurements
- Time Measurements



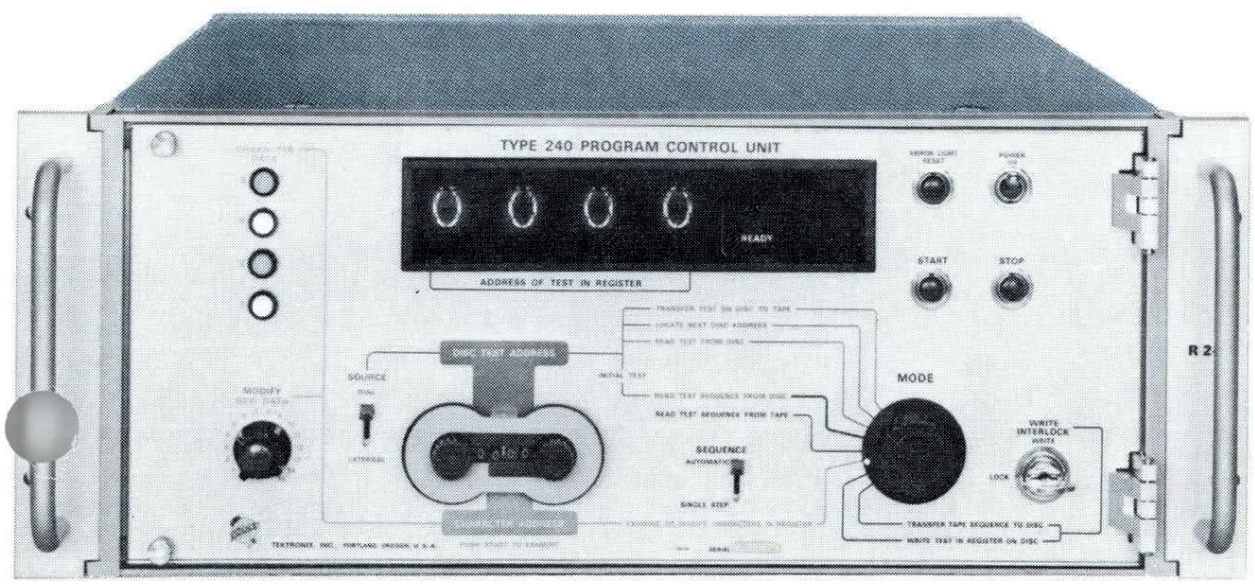
TAPE PUNCH

- 60 Characters/Second
- Permanent Program Storage

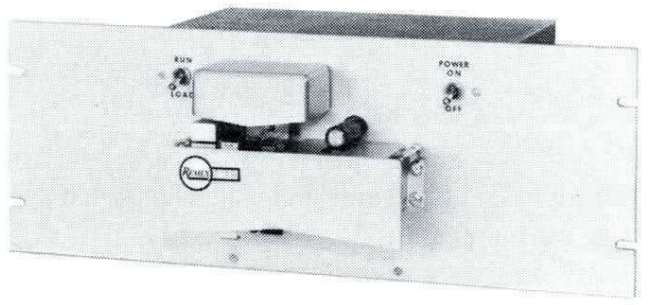


DISC MEMORY

- 1600 Measurement Memory
- 100 Measurements/Second
- Branching

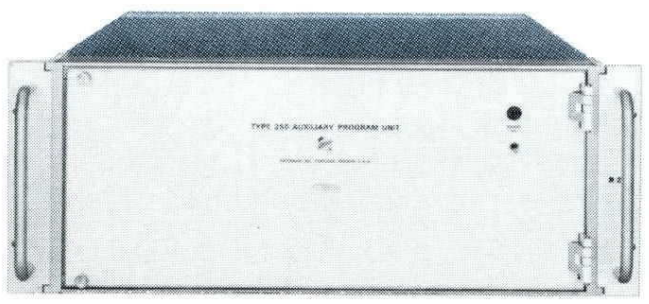


TYPE R240 PROGRAM CONTROL UNIT



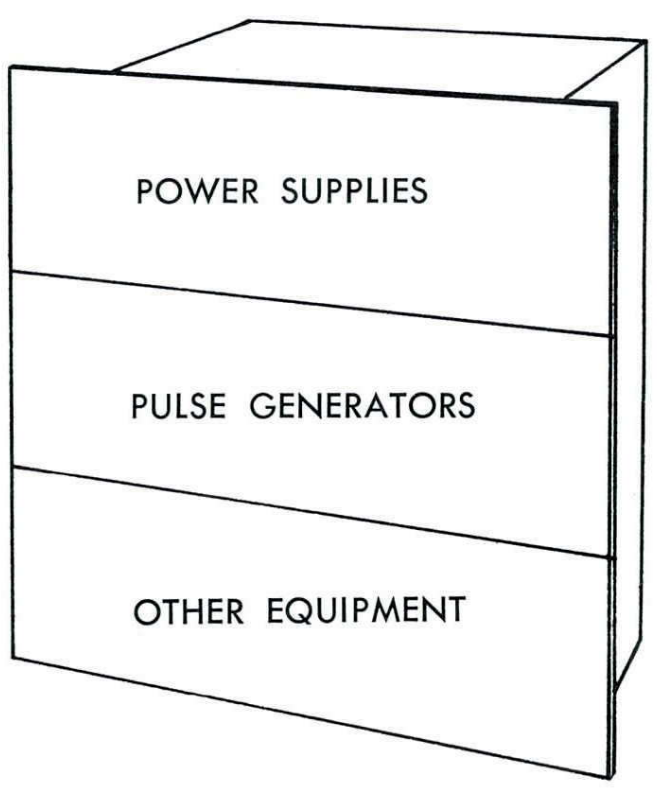
PUNCHED TAPE READER

- 5 Measurements/Second
- Loads Programs on Disc



TYPE R250 AUXILIARY PROGRAM UNIT

- 192 Additional Program Lines
- Program Buffering
- Patch-Panel Capabilities



OPERATING MODES

The Type 240 has eight operating modes that are selected by the front panel mode switch. It will perform any of the eight functions after receiving the start command from an external source or the front panel. The functions are as follows:

TRANSFER TEST ON DISC TO TAPE

This function loads the shift registers of the Type 240 with program data from the Disc Memory as selected by the disc test address. When the register is full, the program data is shifted out of the register to the Tape Punch. When the Tape Punch has punched a complete program tape, the Type 240 is returned to a ready condition.

LOCATE NEXT DISC ADDRESS

This function locates the next disc address after a complete measurement has been made. Measurement programs on the disc are spaced to achieve minimum program access time, providing measurement rates in excess of 100 measurements per second.

READ TEST FROM DISC

This function loads the register with program data from the disc sector selected and tells the Type 568/230 to make the measurement. At the end of the measurement, the Type 240 returns to the ready condition.

READ TEST SEQUENCE FROM DISC

This function loads the shift register with program data from the disc sector selected and tells the Type 568/230 to make the measurement. At the end of the measurement, a print command from the Type 230 loads the shift register with data from the disc sector selected by the next program test address. In the automatic sequence mode, this sequence continues until the Type 240 receives a stop signal and returns to the ready condition.

In this mode of operation the Type 240 can be programmed to branch to a new measurement sequence and stop the sequence on out-of-limits measurements. For example, when making a risetime measurement, a within-limits measurement would continue the normal measurement sequence; an above-limit measurement (slow risetime) can stop the sequence to reject the component, and a below-limit measurement (fast risetime) can branch to a new measurement sequence for reclassifying the component. Out-of-limit measurements are normally programmed to repeat, to check for possible measurement error.

READ TEST SEQUENCE FROM TAPE

This function loads the shift register data from the Punched Tape Reader, tells the Type 230 to make a measurement, and continues making measurements until the Type 240 receives a stop signal. The Punched Tape Reader can program the Type 240 to stop the measurement sequence on out-of-limit measurements. Out-of-limit measurements are normally programmed to repeat, to check for possible measurement error.

EXAMINE OR MODIFY CHARACTERS IN REGISTER

This function displays on the character data lights the data that is in the shift register. Characters are selected by the character address switches and the characters can be modified with the use of the new data switch and the modify pushbutton.

WRITE TEST IN REGISTER ON DISC

This function permits new or modified program data in the register to be written on the disc sector selected. A write inter-lock key prevents accidental writing and changing of data that is already written on the Disc Memory.

TRANSFER TAPE SEQUENCE TO DISC

This function loads the Type 240 shift register with program data from the Punched Tape Reader and writes the program data on the disc sector selected. The write inter-lock key must be turned on and prevents accidental writing on the Disc Memory.

PROGRAM INPUTS

The Type 240 program inputs are in one of two forms: either serial by 4-bit character plus parity at up to 600-kHz character rate, or the Disc Memory input is serial by bit (4 bits plus parity per character) at a 3-MHz bit rate. The optional Disc Memory and Punched Tape Reader are designed specifically for use with the Type 240. The optional Disc Memory provides a storage capacity of 1600 measurements for the Type 240/250 Measurement System (1080 complete measurements for a Type 240/250/250 Measurement System). The program access time for the Disc Memory is 17 ms average and can be optimized to approximately 1 ms through the use of minimum access time programming. The optional Punched Tape Reader provides a maximum speed of 300 characters per second and is used in low-speed measurement systems and for loading programs into the Disc Memory. Other data sources could be used, including magnetic tape readers and computers.

DISC TEST ADDRESS

The disc test address can be selected manually from the front panel or can be controlled externally by a computer or other control device. This permits random access to the Disc Memory's library of up to 1600 independent measurements. For external control of the disc test address, 12 program lines are required with negative logic (true = 0 V to +2 V, false = +6 V to +12 V) plus one external enable line.

PROGRAM LINE OUTPUTS

The Type 240 has 192 program lines that are normally used to program the Type 568 Oscilloscope with the Type 3T5 or 3T6 and 3S5 or 3S6 Programmable Plug-In Units, and the Type 230 Digital Unit. These lines can be used to program other equipment when the Type 568 and Type 230 are not used. The 192 program lines feature negative logic, with true being a saturated NPN transistor to ground and false being an open collector. Space is available on the program boards for special circuitry such as logic level conversion, logical inversion, gating, etc.

OTHER CHARACTERISTICS

POWER REQUIREMENTS

90 V to 136 V or 180 V to 272 V, 48 to 66 Hz, 194 watts at 115 V and 60 Hz. Rear panel selector provides rapid accommodation for 6 line-voltage ranges.

TYPE 240 DIMENSIONS AND WEIGHT

Height	8 in	20.3 cm
Width	16¾ in	42.7 cm
Depth	21⅞ in	55.5 cm
Net weight	37½ lb	17 kg
Domestic shipping weight	≈49 lb	≈24.2 kg
Export-packed weight	≈69 lb	≈31.3 kg

TYPE R240 DIMENSIONS AND WEIGHT

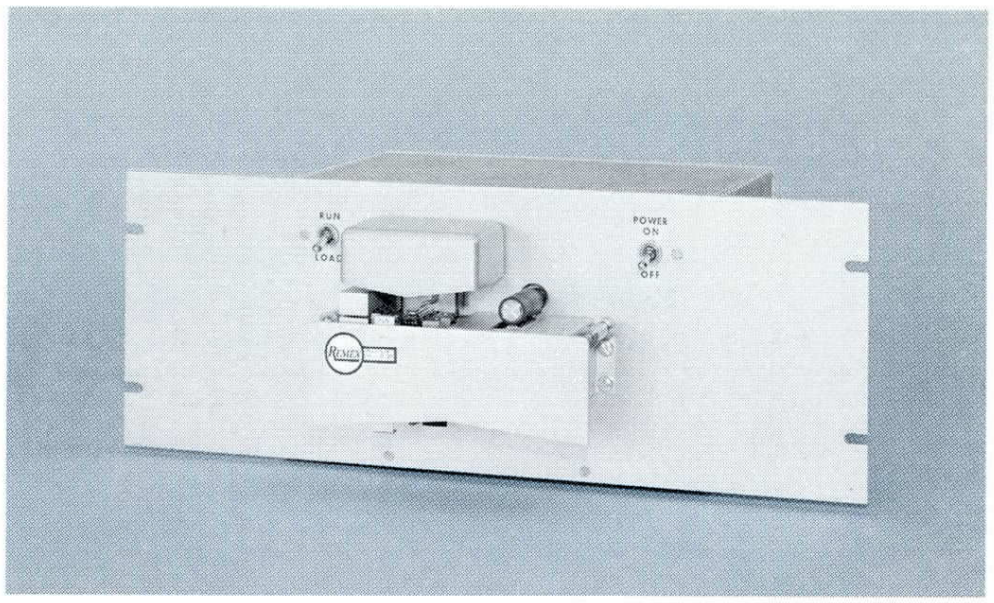
Height	7 in	17.8 cm
Width	19 in	48.3 cm
Depth	22¾ in	57.8
Net weight	38½ lb	17.4 kg
Domestic shipping weight	≈54 lb	≈24.4 kg
Export-packed weight	≈74 lb	≈33.6 kg

INCLUDED STANDARD ACCESSORIES

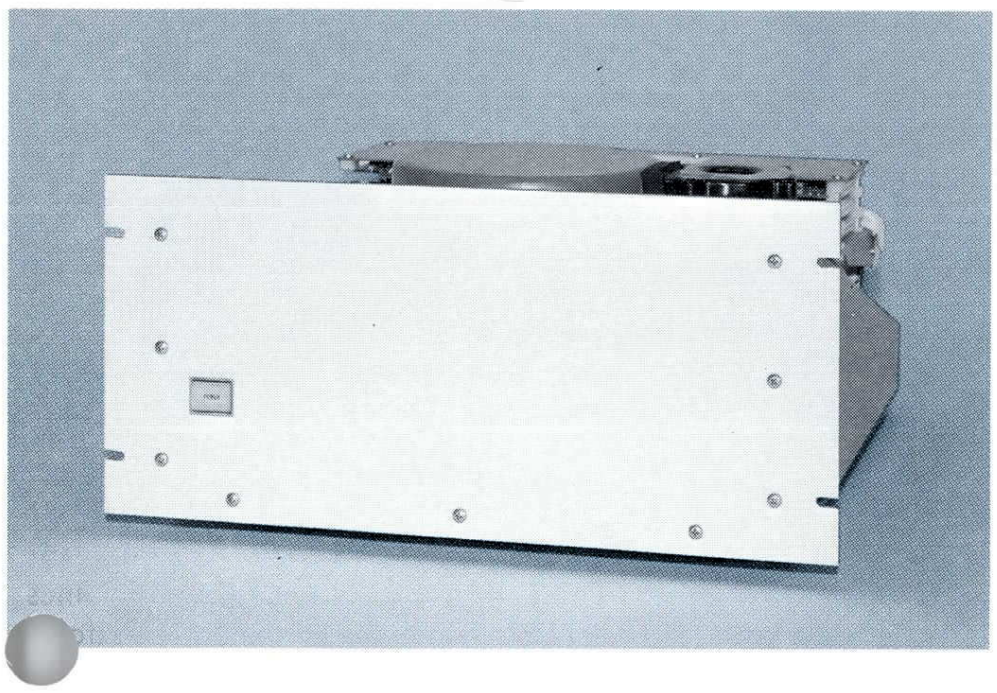
Type 240 only adapter (013-0095-00); Punched Tape Reader only adapter (013-0096-00); 5 36-pin cables with labels (012-0131-00); 36-pin cable with label (012-0131-01); Type 240 program format table tablet (070-0884-00); 2 instruction manuals (070-0749-00). Type R240 also includes mounting tracks (351-0086-00) and mounting hardware.

TYPE 240 PROGRAM CONTROL UNIT $4400

TYPE R240 PROGRAM CONTROL UNIT $4450



OPTIONAL ACCESSORIES



DISC MEMORY

Disc Memory is an 8-track rotation Disc Memory capable of storing 200 measurements per track or a total of 1600 measurements when used with the Type 240 or 240/250 Program Units (1080 measurements with the Type 240/250/250). The format for any test is made up of a fixed word length of 96 characters of 4 bits each plus parity (144 characters with Type 240/250/250). The Disc Memory is 8¾ inches high, 19 inches wide and 19¾ inches deep with a total weight of 62 lb. The instrument is factory wired for 108-V to 132-V operation, 190 watts, 60 Hz. The Disc Memory is made by Data Disc, Inc.

Disc Memory, order 020-0024-00 . . . . . $7200

Disc Memory, 50 Hz power, order 020-0028-00 . . . . . $7200

Disc Memory for Type 240/250/250 System, 50 Hz power, order 020-0029-00 . . . . . $7200

Disc Memory for Type 240/250/250 System, order 020-0025-00 . . . . . $7200

Includes: extender card (012-0151-00); Type 240 to Disc Memory cable (012-0133-00).

LINE SELECTOR TRANSFORMER

The Line Selector Transformer is designed for use with the above optional accessories, where line voltages are encountered outside the accessories' limitations. The transformer is capable of delivering 0.85 kVA, within the voltage ranges of 90 V to 136 V or 180 V to 272 V, 48 to 66 Hz (50 or 60 Hz with above accessories).

Three outlets are available; one wired for 120 V nominal, while the additional two are wired for 115 V nominal.

Line Selector Transformer, order 120-0598-00 . . . . . $193

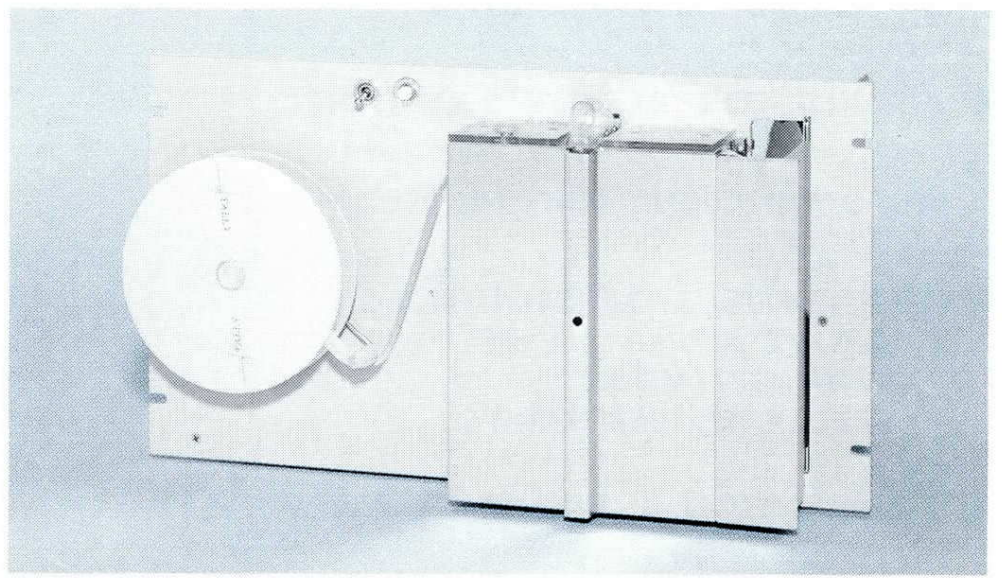
PUNCHED TAPE READER

The Punched Tape Reader is designed for use with the Type 240 for programming the Type 568/230 Digital Oscilloscope System or for loading programs into the Disc Memory. Programs may be generated on the Tape Punch or any standard ASCII tape punch. The Punched Tape Reader has a maximum speed of 300 characters per second. Measurement programs are fixed word length and require 48 4-bit characters plus parity when using the Type 240, 96 4-bit characters plus parity when using a Type 240/250, and 144 4-bit characters plus parity when using a Type 240/250/250 Measurement System. The Punched Tape Reader is 7 inches high, 19 inches wide, 7¾ inches deep and weighs 26 lb. Power requirements are 95 V to 130 V, 150 watts, 60 Hz. The Punched Tape Reader is made by Remex Electronics, Inc.

Punched Tape Reader, order 020-0026-00 . . . . . $1375

Punched Tape Reader, 50 Hz power, order 020-0030-00 $1375

Includes: Type 240 to Punched Tape Reader cable (012-0147-00).



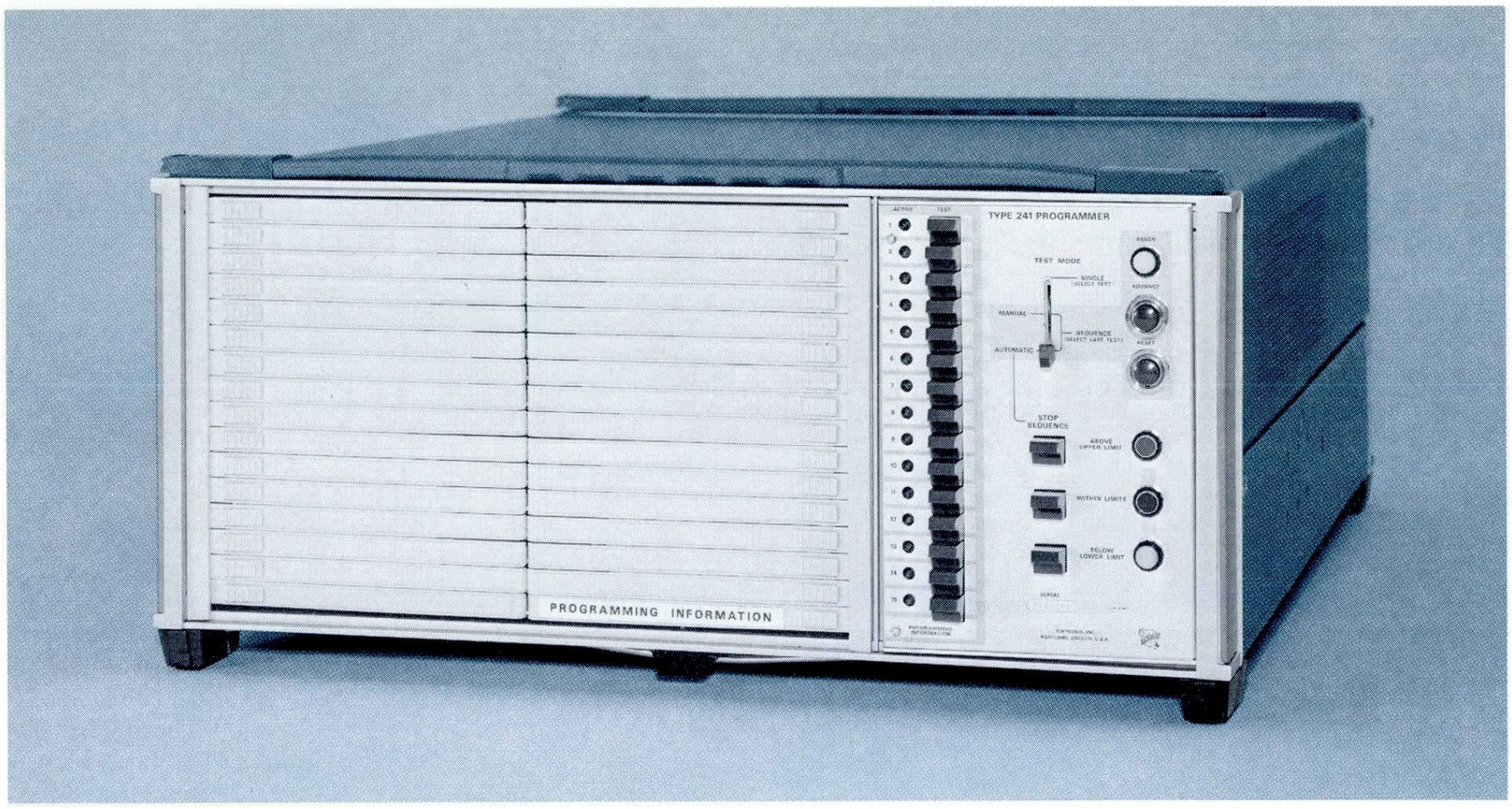
TAPE PUNCH

The Tape Punch is designed to be used with the Type 240 Program Control Unit, and is used for generating new program tapes from the Type 240. Programs stored in the Disc Memory may be transferred via the Type 240 to the Tape Punch for permanent storage. The Tape Punch has a maximum speed of 60 characters per second. It is 10½ inches high, 19 inches wide, 12¾ inches deep and weighs 38 lb. The Tape Punch is factory wired for 105-V to 125-V operation, 320 watts, 50 Hz to 60 Hz. The perforator mechanism is made by Tally, Inc.

Tape Punch, order 020-0027-00 . . . . . $2800

Includes: Type 240 to Punched Tape Reader/Tape Punch cable (012-0146-00).

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.



- ***PROGRAMS TYPE 568/230 DIGITAL OSCILLOSCOPE***
- ***UP TO 15 MEASUREMENTS***
- ***MANUAL OR REMOTE SELECTION***
- ***AUTOMATIC OR MANUAL SEQUENCE***
- ***AUTOMATIC STOP SEQUENCE***
  ABOVE UPPER LIMITS
  WITHIN LIMITS
  BELOW LOWER LIMITS
- ***14 ADDITIONAL PROGRAM LINES***

The Type 241 Program Unit is designed for use with the Type 568 Oscilloscope, Type 3T5 or 3T6, Type 3S5 or 3S6 Programmable Plug-In Units, and the Type 230 Digital Unit. The Type 241 programs all the programmable functions of the Type 568/230 and has an additional 14 lines available for programming other equipment.

The Type 241 provides up to 15 programmed measurements that can be selected manually by front panel push buttons or by external control lines. Automatic or manual sequence of up to 15 measurements is provided with front panel or external control. In the automatic sequence mode, out-of-limit conditions can stop the measurement sequence if desired.

Each program card controls one measurement and has a 159-bit capacity, enough to control the Type 568/230 with two Type 3T5 or 3T6 and Type 3S5 or 3S6 Programmable Plug-In Units and an additional 14 bits for external equipment.

Programs are easy to set up. A special tool is supplied to make insertion and removal of diodes quick and easy. Program cards are labeled to permit a person having minimum training to program the boards. Typically only 15 to 20 diodes need to be inserted for a particular measurement.

The Type 241 program cards are accessible from the front panel and may be easily removed, rearranged or exchanged with others that are intended for different tests. A storage area in the rear of the Type 241 provides storage for up to 15 additional program cards. A storage drawer holds extra diodes and the diode inserting tool.

OPERATING MODES

SINGLE TEST MODE

Any program card/measurement can be selected in any order by a row of numbered push buttons on the front panel. 15 external control lines permit external selection of any measurement in any order by an external ground closure.

MANUAL SEQUENCE MODE

Up to 15 measurements may be stepped through manually with the front panel ADVANCE push button or by an external ground closure. Less than 15 measurements can be manually sequenced without including the undesired tests.

AUTOMATIC SEQUENCE MODE

In the automatic sequence mode up to 15 measurements can be sequenced through at a rate in excess of 100 measurements per second. Measurement limits may be programmed and out-of-limit conditions can stop the measurement sequence if desired. Limit lights on the front panel indicate the status of each test, and the condition which may have interrupted the automatic sequence. The ADVANCE button will advance the Type 241 to the next measurement in the sequence. The RESET button will reset the Type 241 to a ready condition. Both of these functions can be controlled externally by a ground closure. Less than 15 measurements can be automatically sequenced without including the undesired tests.

OTHER CHARACTERISTICS

POWER REQUIREMENTS

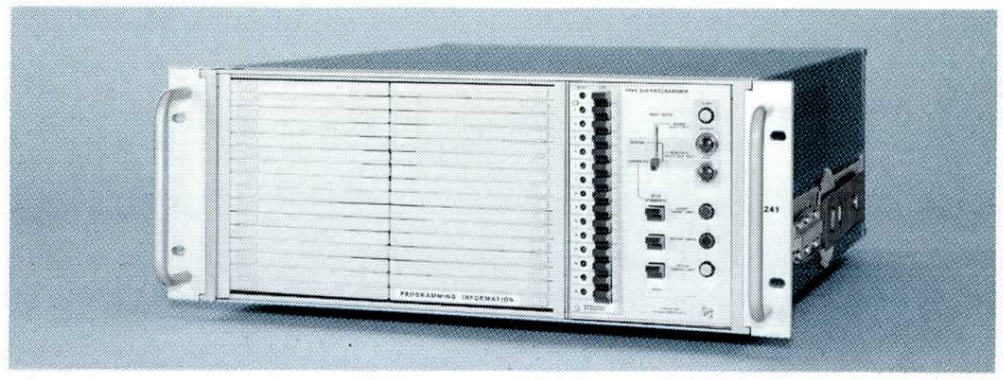
The power required to operate the Type 241 is obtained from the Type 230 Digital Unit.

TYPE 241 DIMENSIONS

Height	8 in	20.3 cm
Width	16¾ in	42.7 cm
Depth	21⅞ in	55.5 cm
Net weight	29½ lb	13.3 kg
Domestic shipping weight	≈41 lb	≈18.6 kg
Export-packed weight	≈61 lb	≈27.6 kg

TYPE R241 DIMENSIONS

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Depth	22¾ in	57.8 cm
Net weight	31½ lb	14.2 kg
Domestic shipping weight	≈43 lb	≈19.5 kg
Export-packed weight	≈63 lb	≈28.6 kg



INCLUDED STANDARD ACCESSORIES

5 interconnecting cables, 6 feet long (012-0131-00); 1 interconnecting cable, 6 feet long (012-0131-01); 15 program circuit cards (670-0285-00); 30 blank labels (334-1337-00); 3 diode packages, each package includes 150 diodes and one diode insertion tool (016-0254-00); 3 diode insertion tools (003-0611-00); 1 test format tablet (070-0908-00); 2 instruction manuals (070-0809-00). Type R241 also includes mounting tracks (351-0086-00) and mounting hardware.

TYPE 241 PROGRAM UNIT **$2200**

TYPE R241 PROGRAM UNIT **$2250**

OPTIONAL ACCESSORIES

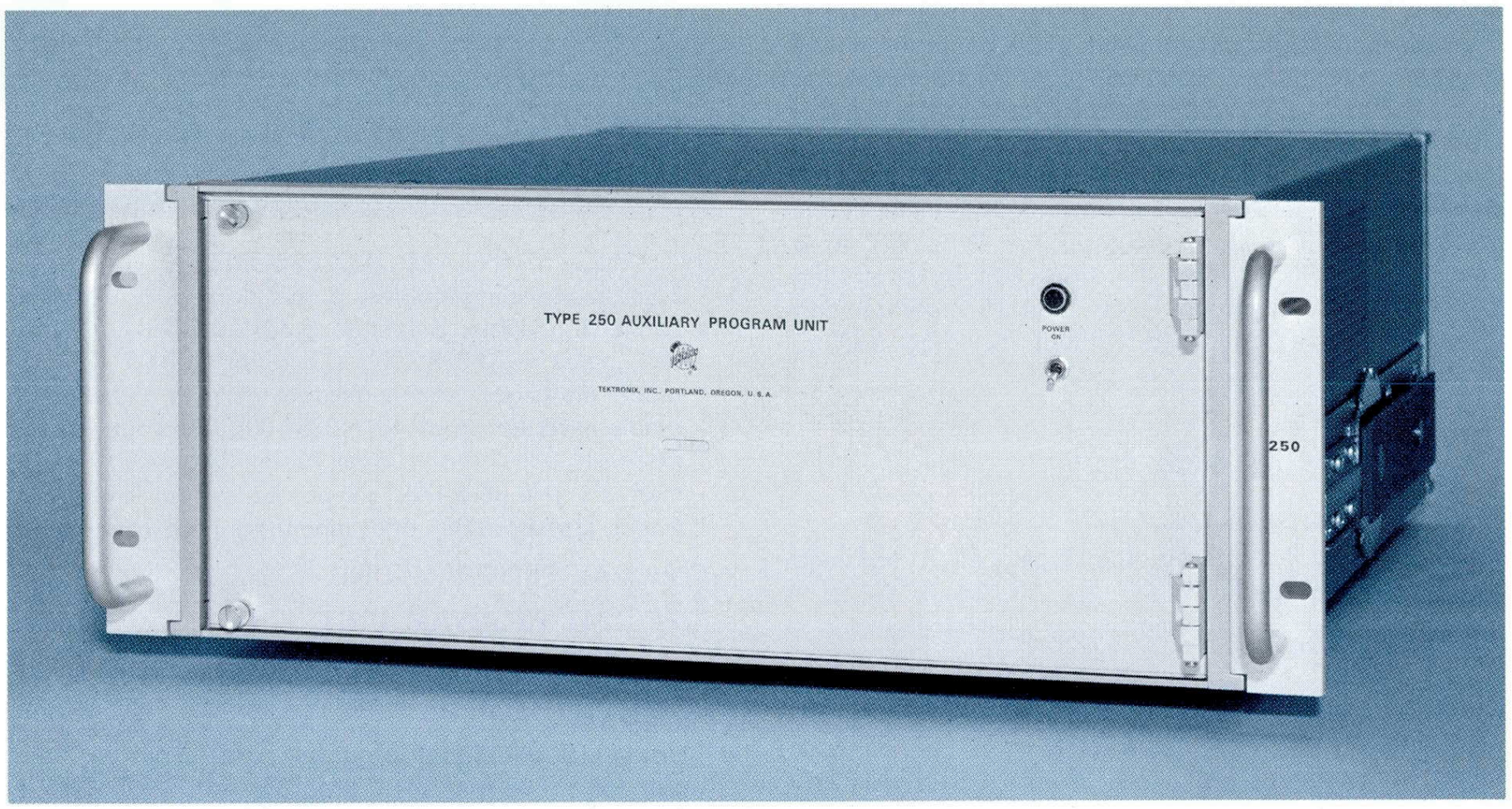
PROGRAM CARD

Up to 15 additional program cards may be stored in the rear of the Type 241. Program cards may be easily removed, rearranged or exchanged with others that are intended for different tests, order 670-0285-00 ..... $44

DIODE PACKAGE

Package of 150 diodes, precut for easy insertion in additional program cards includes diode insertion tool, order 016-0254-00 ..... $60

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.



- ***PROGRAMS***
  - ***Type R116 Pulse Generator***
  - ***Type R293 Pulse Generator***
  - ***Power Supplies***
  - ***Fixtures***
  - ***Other Equipment***
- ***192 PROGRAM LINES***
  - ***48 4-bit Characters***
- ***PROGRAM BUFFERING***
  - ***Level Conversion***
  - ***Level Inversion***
  - ***Digital-To-Analog Conversion***
- ***PATCH-PANEL CAPABILITIES***

The Type R250 Auxiliary Program Unit is designed for use with the Type 240 Program Control Unit and permits external programming of additional equipment such as power supplies, pulse generators, and fixtures. Internal power supplies are available for external programming requirements: +20 V at 300 mA, +10 V at 4 A, +3.6 V at 7 A, and −10 V at 2 A. The Type R250 requires 12 program assembly cards and cables for operation. Program assembly cards consist of one shift register card and two program (standard, resistance, conductance) cards in any combination.

Systems engineering is required with the shift register cards and the program boards. The customer must determine the proper interface required from the Type R250 to the auxiliary equipment to be programmed. Then two program boards are selected and wired to each shift register card to obtain the necessary program functions. Three program boards are available offering the following functions: standard program boards with negative logic programming, resistance program boards, and conductance program boards.

Up to two Type R250's may be used with the Type 240, providing an additional 192 program lines per Type R250. The Type R250 has 48 4-bit characters with 192 program lines. It features program buffering, digital-to-analog conversion and patch panel capabilities.

Two Tektronix programmable pulse generators are available and listed under optional equipment. They come complete with the program assembly cards and cables necessary for use with the Type R250.

Auxiliary Program Unit

R250

POWER REQUIREMENTS

[redacted] V to 136 V or 180 V to 272 V, 48 to 66 Hz, 194 watts at [redacted] V and 60 Hz. Rear panel selector provides rapid accommodation for 6 line-voltage ranges.

TYPE R250 DIMENSIONS AND WEIGHT

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Depth	22¾ in	57.8 cm
Net weight	37½ lb	17 kg
Domestic shipping weight	≈52 lb	≈23.5 kg
Export-packed weight	≈72 lb	≈32.6 kg

INCLUDED STANDARD ACCESSORIES

Type 240 to Type R250 interconnecting cable (012-0134-00); program format table (070-0886-00); two instruction manuals (070-0748-00); mounting tracks (351-0086-00) and mounting hardware.

TYPE R250 AUXILIARY PROGRAM UNIT (requires 12 Program Assembly Cards for operation) **$1700**

TYPE R250 MOD 29

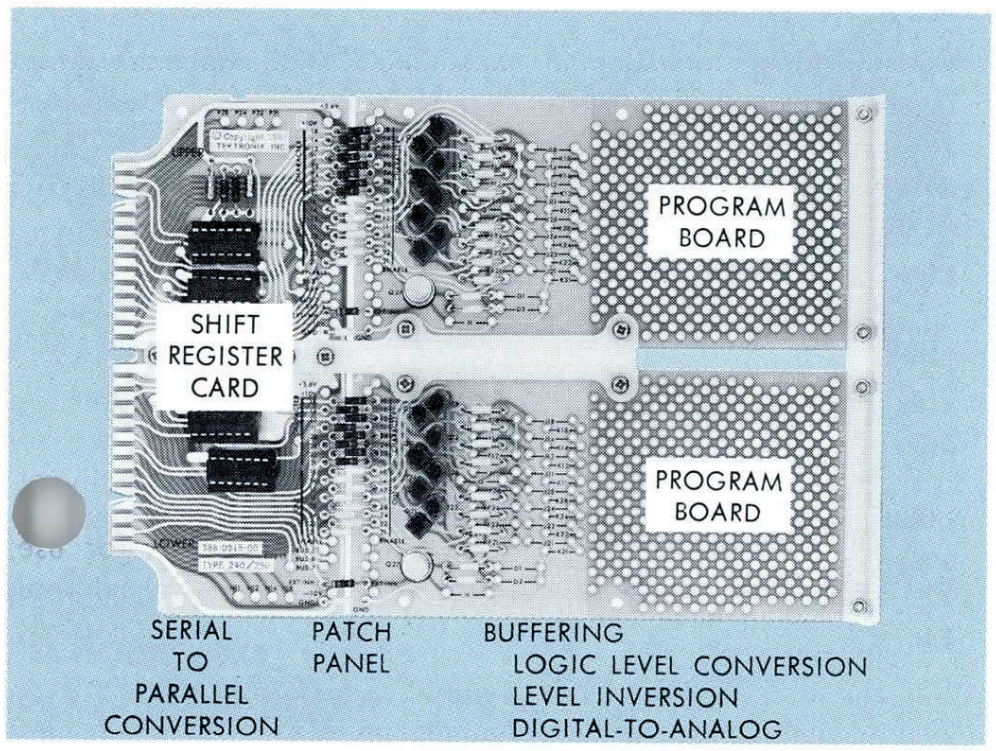
If a second Type R250 is to be used in a system, please indicate on your order, Type R250 MOD 29.

INCLUDED STANDARD ACCESSORIES

Type 240 to Type R250/Type 250 interconnecting cable (012-0135-00); performance check program tape (016-0134-00); program format table (070-0887-00); two instruction manuals (070-0748-00); mounting tracks (351-0086-00) and mounting hardware.

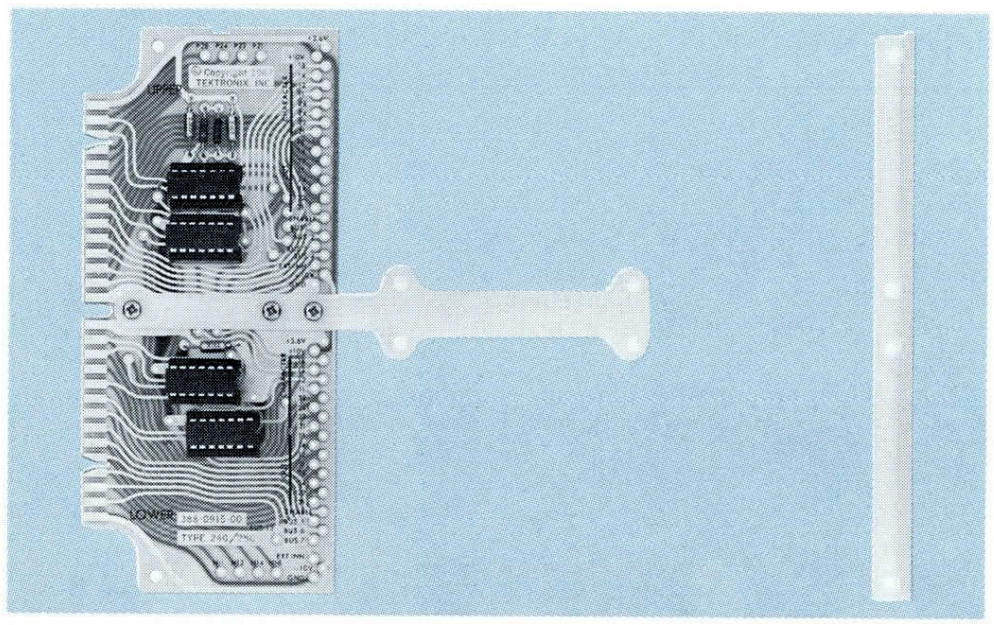
TYPE R250 MOD 29 AUXILIARY PROGRAM UNIT (requires 12 Program Assembly Cards for operation) **$1700**

REQUIRED PROGRAM ACCESSORIES



PROGRAM ASSEMBLY CARDS

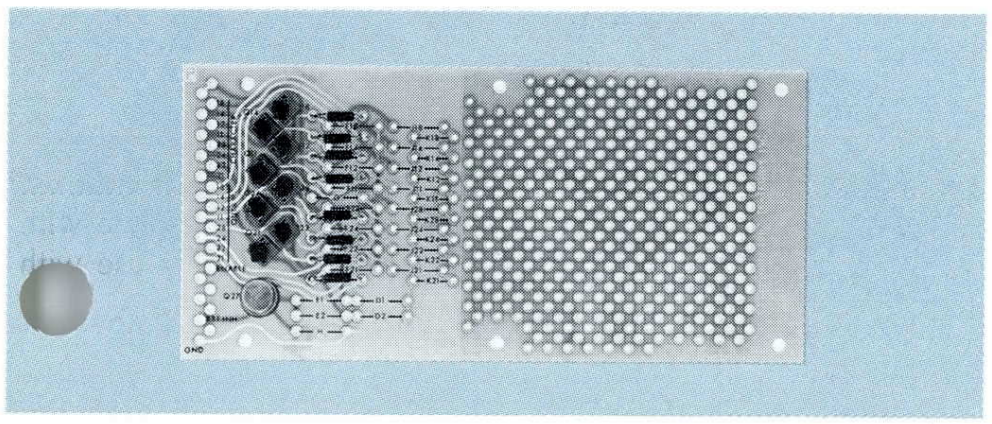
Twelve program assembly cards are required for operation of the Type R250. Each program assembly card consists of one shift register card that does the serial-to-parallel conversion, and two program boards that provide program buffering. Wiring between the shift register card and the program boards is required. Interwiring connections provide patch-panel capabilities. Two Tektronix Programmable Pulse Generators are available with program assembly cards necessary for programming their functions.



SHIFT REGISTER CARD

12 shift register cards are required for the operation of the Type R250. Each card contains a 4-character, 4-bit shift register providing a total of 16 bits for programming. The normal connection from the shift register is 8 bits to the upper program board and 8 bits to the lower program board. Two program boards are required with each shift register card. The program boards may be of the same or different types. The shift register card provides the following connections: 16 program lines to an associated rear panel connector, 8 lines to an adjacent program board on the right, and 8 lines to an adjacent program board on the left.

Order 020-0020-00 . . . . . $77.00



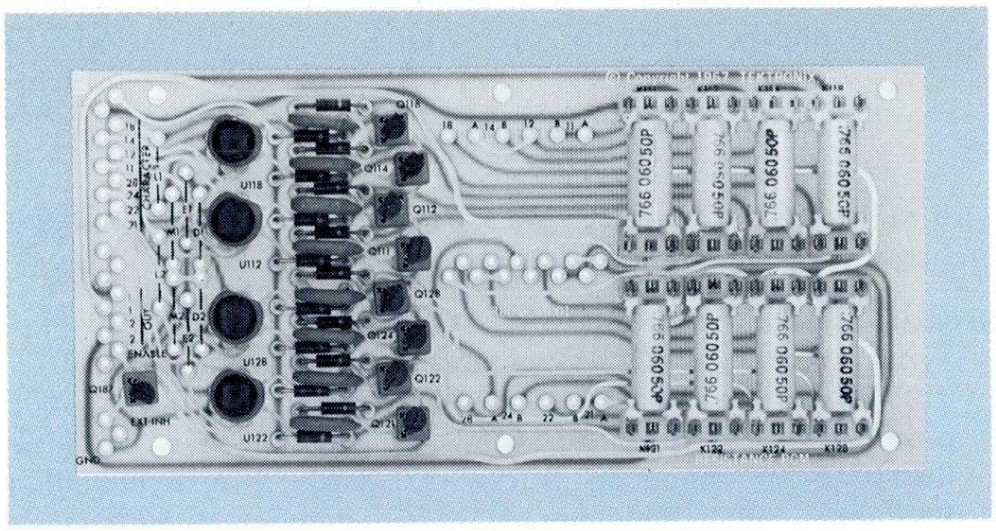
STANDARD PROGRAM BOARD

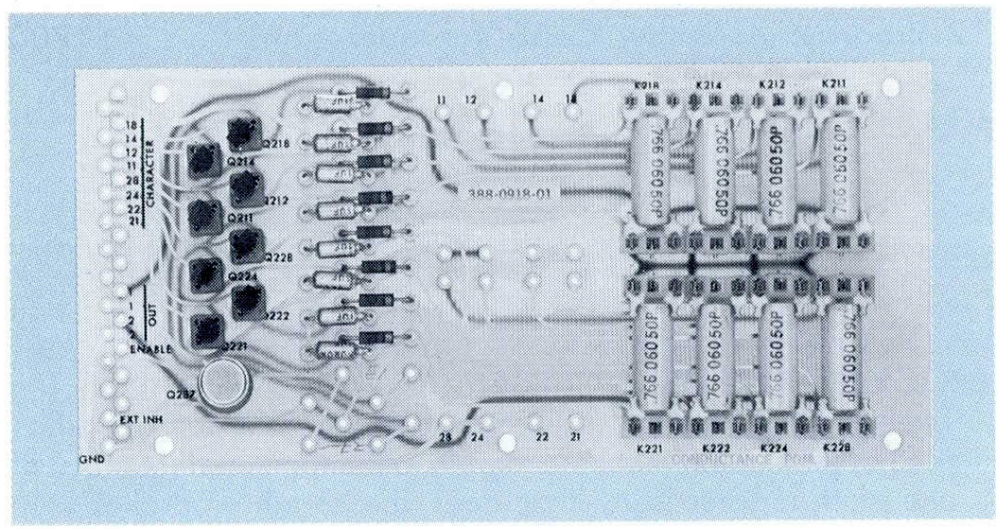
The standard program board contains separate buffer amplifiers for 8 program lines and has provisions for adding isolation diodes and RC delay networks for each program line. The standard program board must be mounted on the shift register card, and inter-wiring connections must be made. The board provides negative logic with true being a saturated NPN transistor to ground, and false being an open collector. Space is available on the board for special circuitry, such as logic level conversion, logical inversion gating, etc.

Order 020-0021-00 . . . . . $27.50

Auxiliary Program Unit

R250





RESISTANCE PROGRAM BOARD

The resistance program board includes buffer drivers, amplifiers, and reed relay switches and coils for switching 8 resistors in a series of resistive networks. Eight program bits from the shift register provide 2 decades of resistance changes (1% increments) for programming analog functions. The resistance program board provides digital-to-analog conversion necessary for programming analog equipment. The resistance program board must be mounted on the shift register card, and inter-wiring connections must be made. Proper resistors must be wired on the board to program the steps desired in the external equipment.

Order 020-0023-00 ..... **$88**

CONDUCTANCE PROGRAM BOARD

The conductance program board is similar to the resistance board, except that 8 resistors are switched in a parallel resistance network. This gives 100 increments of conductance change for programming analog conversions which require linear change of conductance. The conductance program board must be mounted on the shift register card, and interwiring connections must be made. Proper resistors must be wired on the board to program the steps desired in the external equipment.

Order 020-0022-00 ..... **$94**

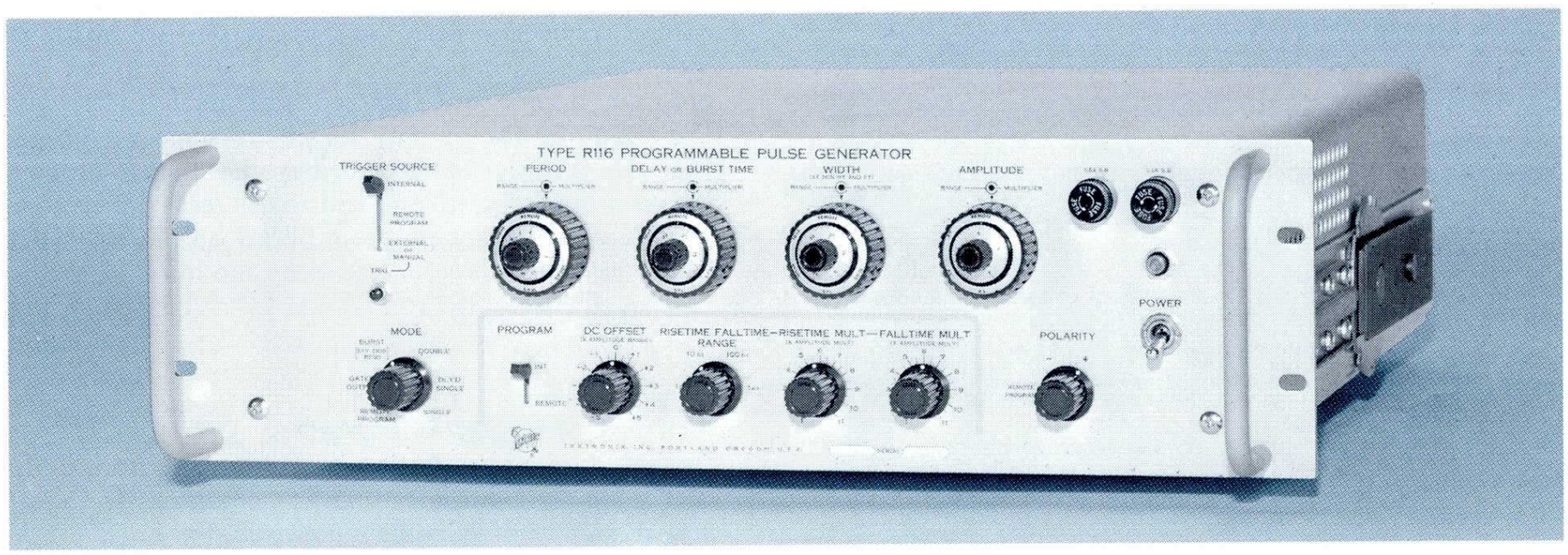
CABLES

The 192 program lines of the Type R250 are available on seven 36-pin connectors on the rear panel. Cables are required to connect the Type R250 to the programmable instruments. Interconnecting cables are included with the optional Tektronix programmable equipment.

6-ft shielded interconnecting cable with 36-pin connector on both ends, order 012-0131-00 ..... $44

8-ft shielded interconnecting cable with 36-pin connector on one end, no connector on other end, order 012-0132-00 .. $28

OPTIONAL EQUIPMENT



TYPE R116 MOD 703L

The Type R116 MOD 703L Programmable Pulse Generator is a modified Tektronix Type R116 Programmable Pulse Generator furnished with 5 Program Assembly Cards and interconnecting cables necessary for the Type R250. Program assembly cards program the Type R116 and are calibrated to the Type R250. The input and output connectors of the Type R116 are moved to the rear panel.

Programmable Pulse Generators

PROGRAMMING BITS required for all range and incremental programming plus mode and polarity programming is 75. If all functions do not require programming, one or more of the programming assembly boards need not be used. Front panel controls are accurate within the indicated tolerances plus an additional 2%.

PULSE PERIOD is programmed in 5 decade ranges (100 ns, 1 μs, 10 μs, 100 μs, 1 ms). Each range can be programmed from X1.0 to X10.9 in 0.1 incremental steps. Accurate within 5% on 100-ns range, within 3% on all other ranges.

PULSE DELAY/BURST is programmed in 4 decade ranges (10 ns, 100 ns, 1 μs, 10 μs) with each range programmed from X5.0 to X54.5 in 0.5 incremental steps. Accurate within (3% + 10 ns).

PULSE RISETIME AND PULSE FALLTIME are programmed from 10 ns to 109 μs. The risetime and falltime is the result of (t_r/t_f range) x (t_r or t_f multiplier) x (amplitude multiplier). Range is programmed in 4 decade steps (1 ns, 10 ns, 100 ns, 1 μs). Risetime and falltime multipliers are separately programmable, but share a common range program. Multiplier ranges are from X1.0 to X10.9 in 0.1 incremental steps. Accurate within 10% above 10 ns on the 1-ns and 10-ns range, within 5% on the 100-ns and 1-μs range. When (t_r/t_f range) x (t_r or t_f multiplier) x (amplitude multiplier) is less than 10 ns, the output risetime or falltime is less than 11 ns, uncalibrated.

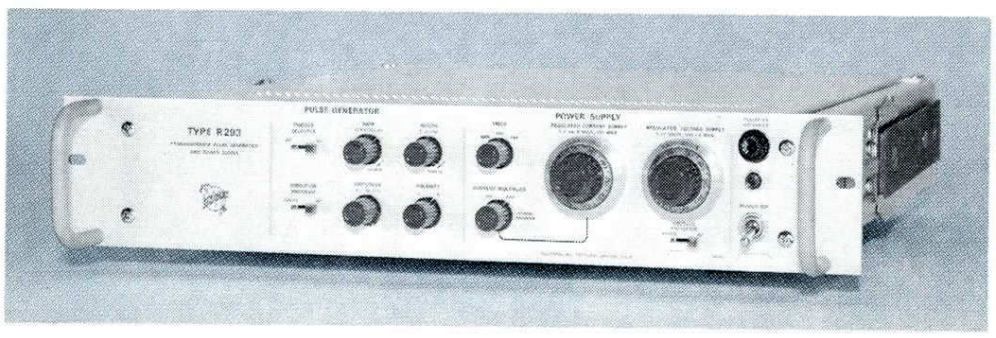
PULSE AMPLITUDE is programmed in 3 ranges (0.2 V, 0.5 V, 1 V) with multipliers from X2.0 to X9.9 in 0.1 incremental steps. Amplitude into 50 Ω is accurate within (3% + 15 mV) on 0.2-V range; within (3% + 25 mV) on 0.5-V range; within (3% + 50 mV) on 1-V range.

PULSE WIDTH is programmed in 4 decade ranges (10 ns, 100 ns, 1 μs, 10 μs) with each range programmed from X5.0 to X54.5 in 0.5 incremental steps. Accurate within 5% on 10-ns range, within 3% on all other ranges.

PULSE DC OFFSET RANGE is —X4.9 to +X4.9 in 0.1 incremental steps, times the pulse amplitude range. Accurate within (5% ±200 mV).

TYPE R116 MOD 703L **$3050**

Includes: 5 program assemblies for the Type R250; card P7, pulse delay (672-0207-01); card P8, pulse period, mode (672-0208-01); card P9, pulse width, amplitude, t_r/t_f decade, offset (672-0208-02); card P10, pulse width multiplier, amplitude multiplier (672-0209-01); card P11, pulse risetime multiplier, falltime multiplier (672-0209-02); Type R116 MOD 703L to Type R250 interconnecting cable (012-0141-00); test format tables; standard accessories of Type R116; two instruction manuals with MOD 703L information added.



TYPE R293 MOD 703M

The Type R293 MOD 703M is a modified Tektronix Type R293 Programmable Pulse Generator and Power Supply Unit furnished with a program assembly (1 shift register card with 2 program boards installed and wired) for the Type R250, designed to program the pulse amplitude and pulse width of the Type R293. All input and output connectors of the Type R293 are moved to the rear panel. The following performance characteristics apply to the Type R293 MOD 703M programmed by the Tektronix Type R250 Auxiliary Program Unit and using the program assembly card furnished with the Type R293. Characteristics of the Type R293 Programmable Pulse Generator and Power Supply Unit are as follows.

PULSE GENERATOR

Programmable Characteristics

PULSE AMPLITUDE is programmed with 4 bits in 0.5-V increments over a range of 6 V to 12 V, accurate within 3% of programmed value.

PULSE WIDTH is programmed with 10 bits in 1-ns increments over a range from 2 ns to 250 ns, accurate within (3% + 3 ns).

Non-Programmable Characteristics

RISETIME is ≤1 ns at maximum amplitude.

FALLTIME is ≤1 ns at ≥20 ns width, ≤2 ns at 3 to 20 ns width at maximum amplitude.

REPETITION RATE is ≤10 kHz to 90-100 kHz, continuously variable, uncalibrated.

POLARITY is selectable, positive or negative.

POWER SUPPLY

REGULATED CURRENT SUPPLY is 300 μA to 300 mA (continuously variable) at up to 20 V, positive or negative polarity. Accuracy within ± (3% of dial reading) +50 μA, or ± (3% of programmed value) +50 μA. ±1% maximum change with line change from 93.5 V to 135 V. Ripple ≤0.5% or 50 μA, whichever is greater. Overshoot ≤0.5% of change in programmed current.

REGULATED VOLTAGE SUPPLY is 0 to ±50 V (continuously variable) at up to 200 mA. Accuracy within ± (2% of dial reading) +25 mV, or ± (3% of programmed value) +25 mV. ±1% maximum change with line change from 93.5 V to 135 V. Ripple ≤0.05% or 5 mV, whichever is greater. Overshoot ≤5% of change in programmed voltage.

OTHER CHARACTERISTICS

PRETRIGGER PULSE is ≥ + ½ V into 50 Ω and ≥ + 2 V into open circuit, occurs approximately 200 ns before leading edge of main pulse. 100-ps maximum jitter between pretrigger and leading edge of main pulse.

EXTERNAL TRIGGER REQUIREMENT is ≥2-V; DC to 100 kHz; ≤1-μs risetime; 200 V DC maximum.

POWER REQUIREMENTS are 93.5 V to 135 V or 187 V to 270 V, low or high range selected by rear panel switch. 50 to 400 Hz, 65 watts maximum.

TYPE R293 MOD 703M **$1425**

Includes: Program assembly card for Type R250 (672-0210-01); Type R293 MOD 703M to Type R250 interconnecting cable (012-0142-00); measurement format table; two instruction manuals with MOD 703M additions; plus included standard accessories of the Type R293.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Sampling Head Multiplexing Systems

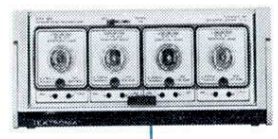
1 - 4 Heads

The Types 286, 287, and R288 form a Sampling Head Multiplexing Family designed for use with Tektronix Programmable Sampling Units such as the Type 3S5 or 3S6.

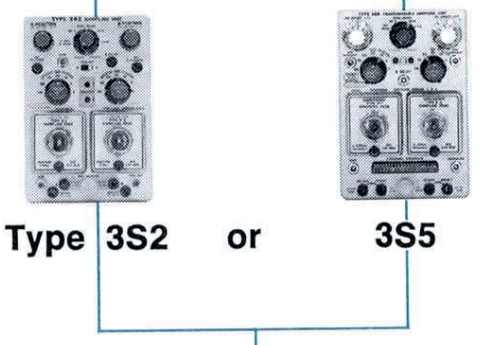
For a small multiplex system one Type 286 is required which will accept up to four sampling heads. The Type 286 can be programmed to select any one of the four sampling heads for display on either channel of the dual-trace sampling vertical unit at any given time. Indicator lamps for each head show which of the dual-trace sampling unit channels has been selected for display.

When more than four channels of information are required, the Type 287 must be used. The Type 287 accepts up to four Type 286 Multiplexing Units as plug-ins, allowing any two of sixteen sampling heads to be selected for display. Thus a sixteen head multiplexing system would consist of one Type 287, four Type 286's and sixteen Sampling Heads.

For applications requiring the multiplexing of more than sixteen heads, the Type R288 Master Controller must be used. The Type R288 acts as a controller for four Type 286 Sampling Head Multiplex Units with the Type 286's installed in the Type R288 as plug-in units. In addition, the Type R288 will operate up to three companion Type 287 Multiplex Controllers. The programmer can select any one of up to 64 heads for display on Channel A of the sampling vertical unit and any one of the 63 remaining heads for display on Channel B.

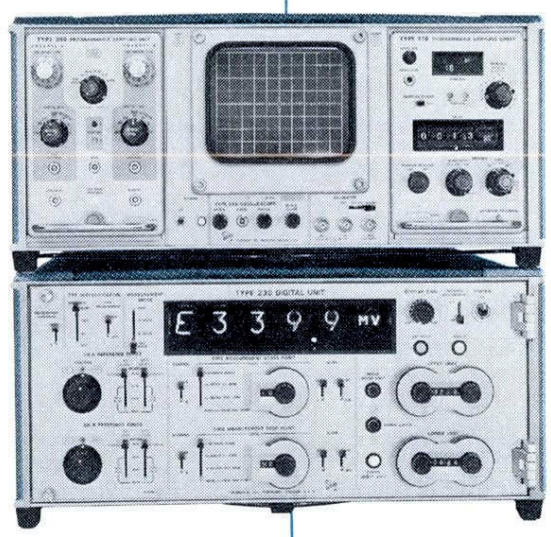


Type 286

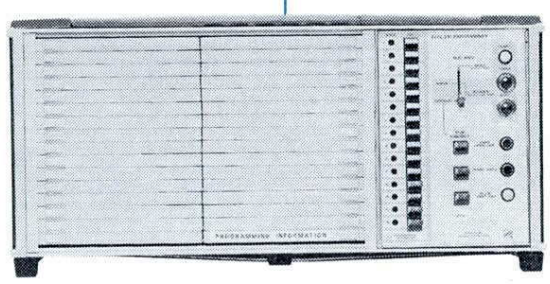


Type 3S2 or 3S5

Type 568



Type 230

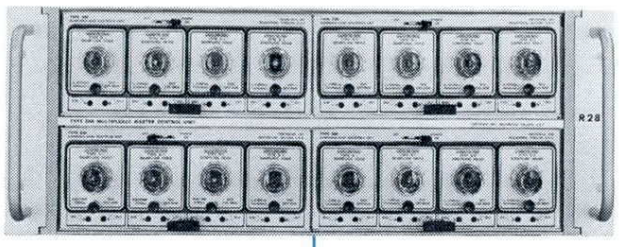


Type 241

Sampling Head Multiplexing Systems

5 - 16 Heads

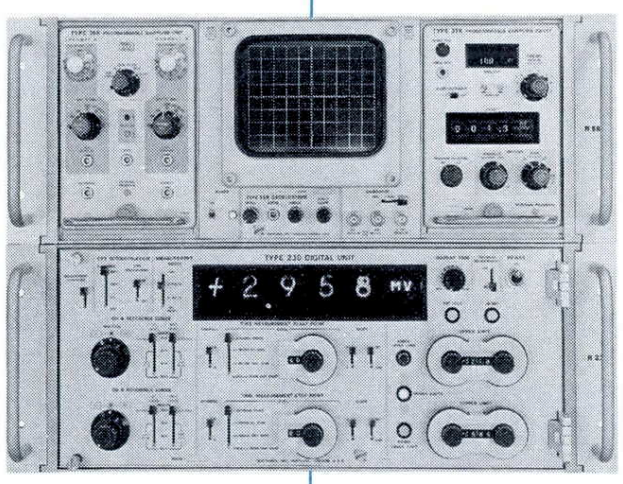
Type R287



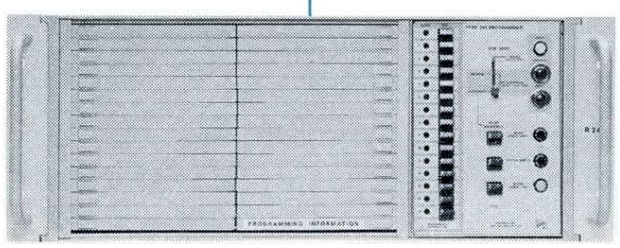
with 2 to 4 Type 286's

Type 3S2, 3S5, or 3S6

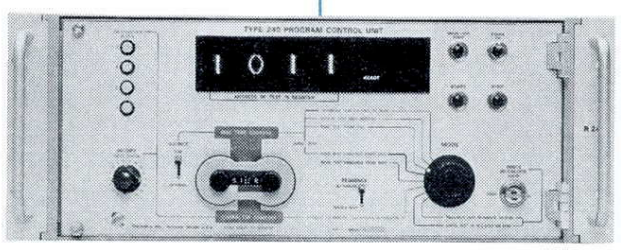
Type R568



Type R230

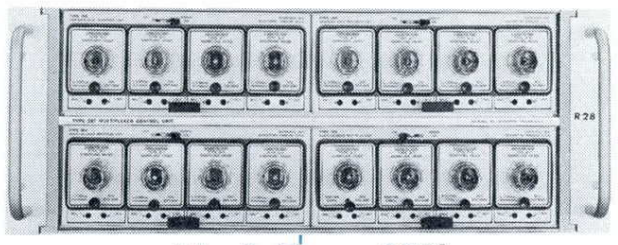


Type R241 or Type R240



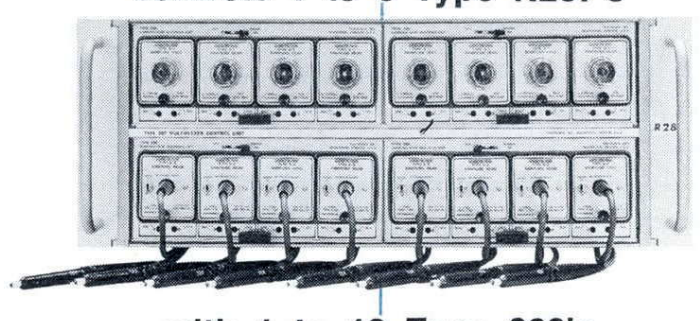
17 - 64 Heads

Type R288



with 4 Type 286's

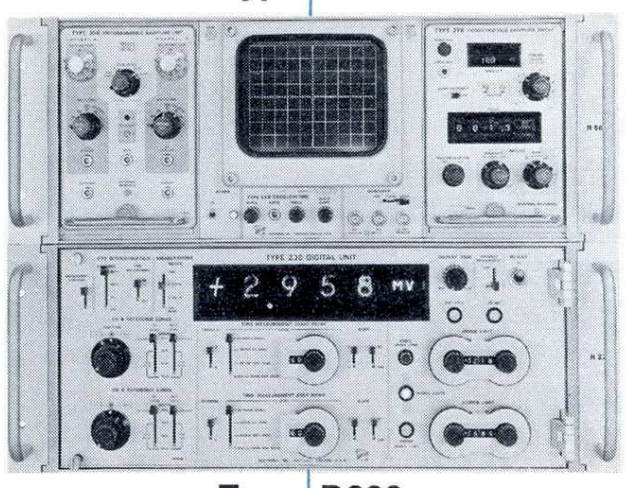
controls 1 to 3 Type R287's



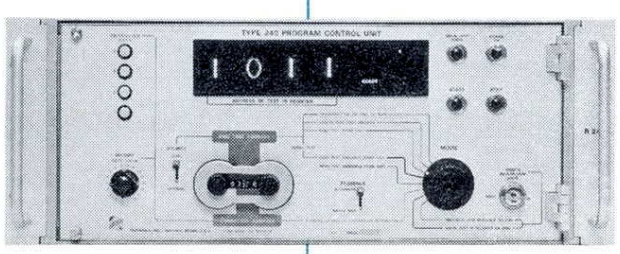
with 1 to 12 Type 286's

Type 3S6

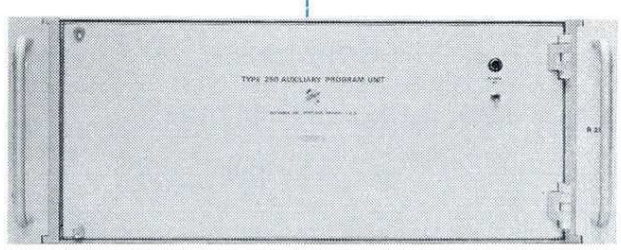
Type R568



Type R230



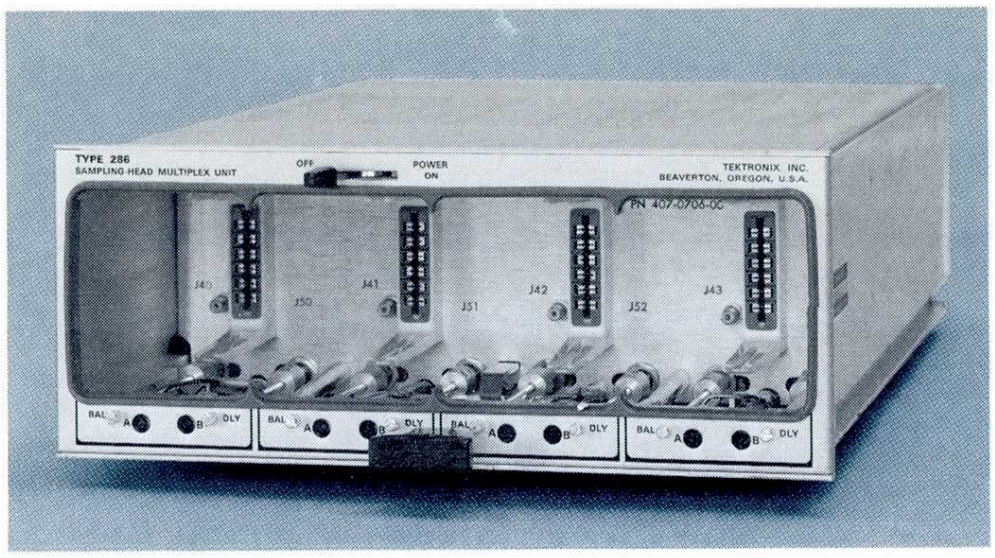
Type R240



Type R250

NEW

286 Multiplex Unit



The Type 286 Sampling-Head Multiplex Unit is intended for use with Tektronix Programmable Sampling Units such as the Type 3S5 or 3S6. It may also be used with the Type 3S2. The Type 286 is a Programmable Sampling-Head Selector that accepts up to four sampling heads. Indicator lamps for each head indicate which of the dual-trace sampling unit channels has been selected for display. Front-panel delay and balance adjustments are provided for each head.

Displayed Noise (Introduced by Type 286)
Less than 1.2X noise specified for selected head.

Deflection Factor Change (Introduced by Type 286)
Within 1%

Power Requirements
Quick-change, line voltage selection permits operation from any of the following voltages: 90 V to 110 V, 104 V to 126 V, 112 V to 136 V, 180 V to 220 V, 208 V to 252 V, 224 V to 272 V. The Type 286 will operate over a line-frequency range from 48 Hz to 440 Hz with a power consumption of approximately 25 watts at 115 VAC.

Dimensions and Weights

Height	2½ in	6.4 cm
Width	8 in	20.4 cm
Depth	12 in	30.5 cm
Net Weight	6 lb	2.7 kg
Domestic shipping weight	9 lb	4.1 kg
Export-packed weight	17 lb	8.0 kg

Included Standard Accessories
None

TYPE 286 ..... **$725**

Optional Cabinet
Cabinet for Type 286, permits bench-top use, order 437-0110-00 ..... $38.50

Optional Accessories
Rack adapter, used together with Type 286 mounting kit (016-0157-00), the rack adapter provides rackmounting of a single Type 286 together with a half rack with generator, order 016-0086-01 ..... $135

Rack mounting kit, allows the mounting of a single Type 286 in the 016-0086-01 rack adapter, order 016-0157-00 ..... $20.00

Panel assembly blank, a half width blank panel encloses unused portion of rack adapter 016-0086-01, order 016-0081-00 ..... $8.00

Cord, power, order 161-0010-03 ..... $3.10

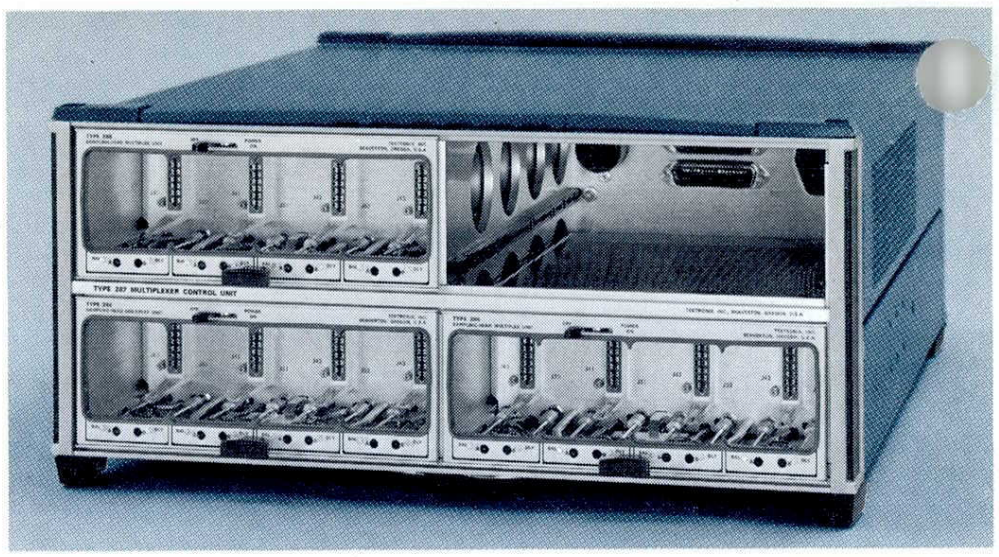
Adapter, 3-to-2 wire, order 103-0013-00 ..... $ .35

Manual, composite (Type 286, 287, 288), order 070-1007-00 ..... $5.00

Cable labels for Type 286, to identify cable connectors, order 334-1526-00 ..... $ .50

NEW

Multiplex Control Unit 287



Three optional Type 286's installed

The Type 287 Multiplex Control Unit is designed for use with Tektronix Type 286 Sampling-Head Multiplex Units when operated with Sampling Units such as the Type 3S5 or 3S6. The Type 287 is a Programmable Control Unit that accepts up to four Type 286's as plug-in units, allowing any two of sixteen heads to be selected for display. The Type 287 supplies AC power for operating the Type 286's via receptacles mounted at the rear of each plug-in compartment (thru a relay controlled by the sampler). Connectors on the rear of the instrument provide for driving probe nose choppers simultaneously with the head selected for display.

Displayed Noise (Introduced by Types 286 and 287)
Less than 1.2X noise specified for selected heads.

Deflection Factor Change (Introduced by Types 286 and 287)
Within 1%

Power Requirements
The Type 287 acts as a convenience outlet for each of the four Type 286's mounted within. DC power for operation of the Type 287 is supplied by the sampling unit with which it is used.

Dimensions and Weights

Height	8 in	20.4 cm
Width	16-13/16 in	42.7 cm
Depth	21-7/8 in	55.6 cm
Net weight	19 lb	8.6 kg
Domestic shipping weight	30 lb	13.6 kg
Export-packed weight	50 lb	22.8 kg

Included Standard Accessories
Cable labels for Type 287 (334-1527-00); 3-to-2 wire adapter (103-0013-00); two instruction manuals (070-1007-00).

TYPE 287 ..... **$600**

Type R287 Dimensions and Weights

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Depth	22¾ in	57.8 cm
Net weight	19 lb	8.6 kg
Domestic shipping weight	30 lb	13.6 kg
Export-packed weight	50 lb	22.8 kg

Included Standard Accessories
Cable labels for Type 287 (334-1527-00); 3-to-2 wire adapter (103-0013-00); mounting tracks (351-0086-00); two instruction manuals (070-1007-00).

TYPE R287 ..... **$650**

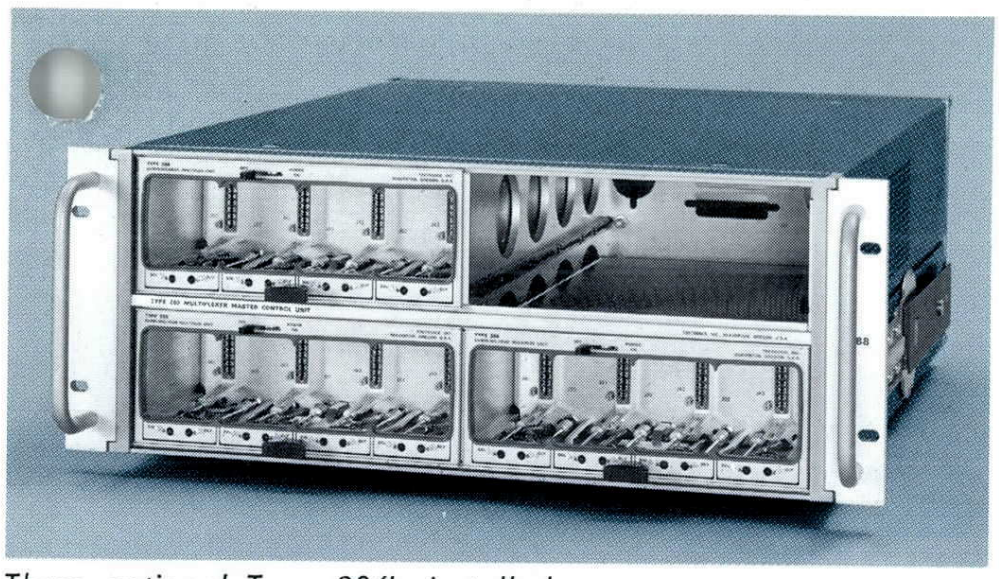
Optional Accessories
Drawer, mounts in unused compartments. Provides storage area for accessories, order 014-0034-00 ..... $25

Type R287 recess mounting kit, recesses R287 front panel 4 inches into rack and covers with blank panel door. Provides space to route sampling head signal cables to rear of rack. Type R287 recess mount occupies 8¾ inches of vertical rack space, order 016-0158-00 ..... $60

See facing page for required cables.

NEW

R288 Multiplex Master Controller R288



Three optional Type 286's installed

The Type R288 Multiplex Master Controller is designed for use in multiplexing sampling head systems where the selection of more than sixteen sampling heads is required. The Type R288 acts as a controller for up to four Type 286 Sampling Head Multiplex Units with the Type 286's installed in the Type R288 as plug-in units. In addition, the Type R288 will operate up to three companion Type R287 Multiplex Controllers. Through the use of six binary coded lines for each sampling unit display channel, the programmer can select any one of up to 64 heads for display on Channels A and any one of the 63 remaining heads for display on Channel B. The Type R288 supplies AC power for operating the Type 286's. Connectors on the rear panel of the instrument provide the output for driving probe nose choppers corresponding to the heads selected for display.

Displayed Noise (Introduced by Types 286, 287 and R288)
Less than 1.2X noise specified for selected head.

Deflection Factor Change (Introduced by Types 286, 287 and R288)
Within 1%

Power Requirements
Receptacles mounted at the rear of each Type R288 plug-in compartment supply AC power for operating the Type 286's via a sampler controlled relay. DC power for operating the Type R288 is supplied by the sampling unit used.

Dimensions and Weights

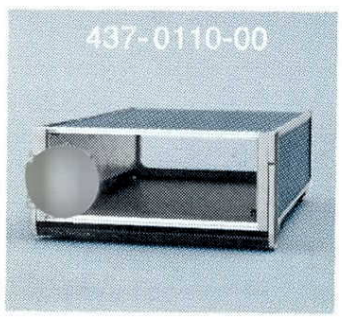
Height	7 in	17.8 cm
Width	19 in	48.3 cm
Depth	22¾ in	57.8 cm
Net Weight	19 lb	8.6 kg
Domestic shipping weight	30 lb	13.6 kg
Export-packed weight	50 lb	22.8 kg

Included Standard Accessories
Cable labels for the Type R288 (334-1528-00); 3-to-2 wire adapter (103-0013-00); mounting tracks (351-0086-00).

TYPE R288 ..... $900

Optional Accessories
Drawer, mounts in unused compartments. Provide storage area for accessories, order 014-0034-00 ..... $25

Type R288 recess mounting kit, recesses R288 front panel 4 inches into rack and covers with blank panel door. Provides space to route sampling head signal cables to rear of rack. Type R288 recess mount occupies 8¾ inches of rack space vertically, order 016-0158-01 ..... $60



Sampling Unit to Multiplexer Cables

Type 3S6 to Multiplexer, order 012-0177-00 ..... $ 65
Type 3S5 or 3S2 to Multiplexer, order 012-0178-00 ..... $125

MUX*-System Configuration	Number of S. Heads	R288-to-287/ R287 Interconn. Cables	Signal Chopper** Cables
286 (Rack-mounted plug-in)	1 to 4	---	012-0186-00
1-287/R287 (1 to 4-286's)	5 to 16	---	012-0131-02
1-287/R287, 1-R288 (5 to 8-286's)	17 to 32	1 ea., 012-0177-00 012-0131-00	"
2-287/R287, 1-R288 (9 to 12-286's)	33 to 48	2 ea., 012-0177-00 012-0131-00	"
3-287/R287, 1-R288 (13 to 16-286's)	49 to 64	3 ea., 012-0177-00 012-0131-00	"

* MUX - Abbreviation for multiplexer; complies with Mil Std 12 C.
** Order choppers separately.

MUX - System Configuration	Number of S. Heads	Programmer-to-MUX Cables		
		241/R241	240/R240	R250
286 (Rack-mounted plug-in)	1 to 4	012-0176-00	012-0131-00	012-0131-00
1-287/R287 (1 to 4-286's)	5 to 16	"	"	"
1-287/R287, 1-R288 (5 to 8-286's)	17 to 32	---	---	"
3-287/R287, 1-R288 (9 to 12-286's)	33 to 48	---	---	"
3-287/R287, 1-R288 (13 to 16-286's)	49 to 64	---	---	"

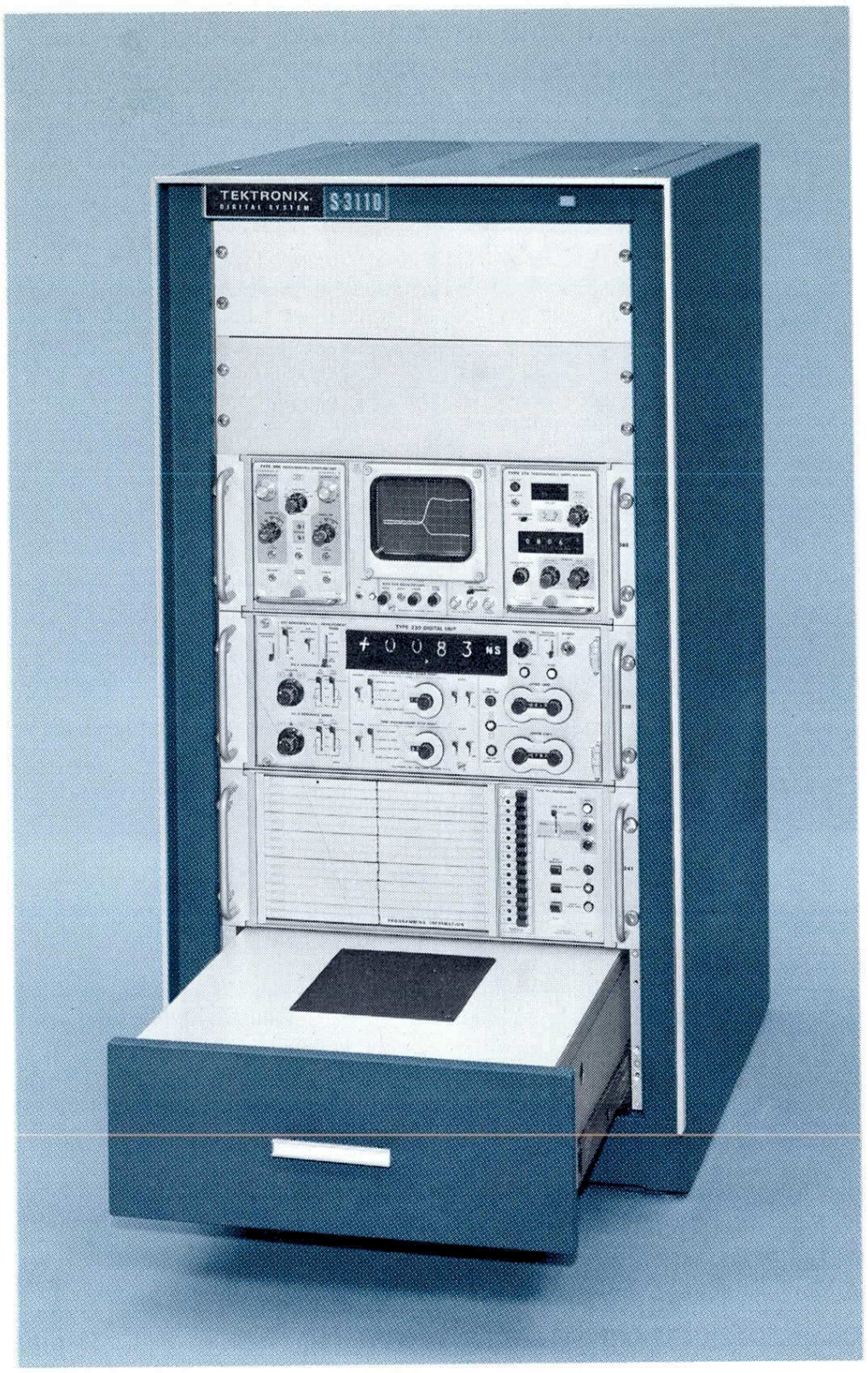
User Built Programmer to Multiplexer Cable, order 012-0132-00 ..... $28
012-0132-00 is an 8-ft cable with a single 36-pin connector suitable for use with any multiplexing system configuration. If only the connector is desired, order 131-0293-00.

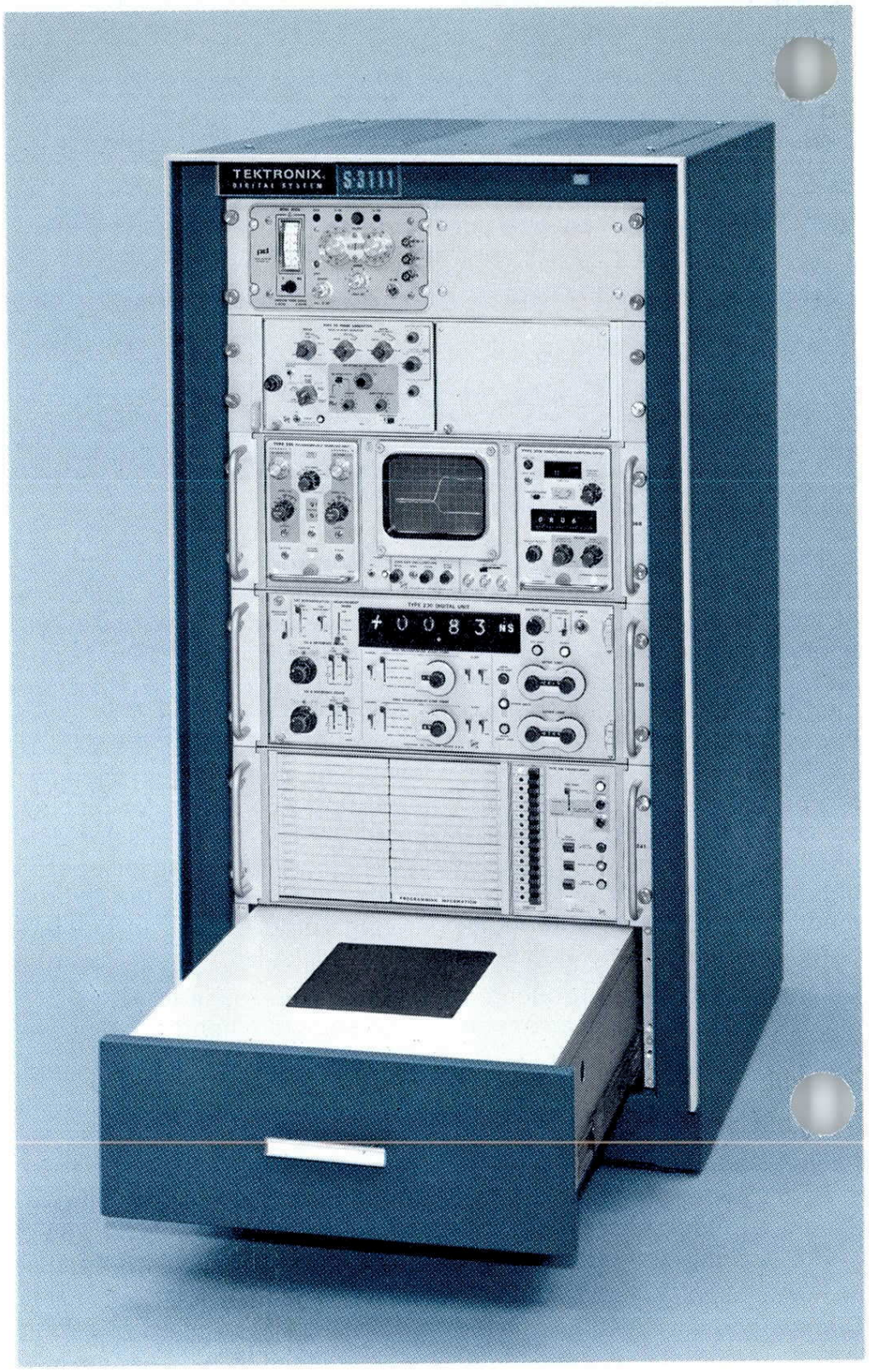
Interconnection Accessory Description

Name, Part Number	Price	Description
Cable (012-0131-00)	$ 44	Interconnecting cable, 6-ft, 36-pin to 36-pin.
Cable (012-0132-00)	$ 28	Program cable, 8-ft, 36-pin connector on one end, no connector on other end.
Cable (012-0176-00)	$ 40	Program cable to interconnect Type 286 or Type 287 with Type 241, 6-ft, 36-pin to 36-pin.
Cable (012-0177-00)	$ 65	Signal cable to connect Type 286, Type 287 or Type R288 with Type 568 (Type 3S6) 6-ft, 36-pin to 36-pin.
Cable (012-0178-00)	$125	Signal cable to interconnect Type 286, Type 287, or Type R288 with Type 3S2 or 3S5, 6-ft, 36-pin to two sampling head connectors.
Cable (012-0186-00)	$ 65	Chopper adapter cable, permits chopper quad to be driven directly from a Type 230, required for use with Type 286, not required with Type 287 or Type R288.
Chopper Quad (015-0155-01)	$375	Chopper quad—set of four probe choppers including attenuators for use with Type S-3 Sampling Heads to provide ground reference for DC of pulse displays.
Connector (131-0293-00)	$ 5.20	36-pin program connector.

S-3110 MODEL 651A Automated Measurement System

S-3110 MODEL 651A





- ***DYNAMIC MEASUREMENTS***
  - ***PULSE RISETIME AND FALLTIME***
  - ***PULSE WIDTH AND PERIOD***
  - ***PROPAGATION DELAY AND STORAGE TIME***
  - ***PULSE AMPLITUDE AND SATURATION VOLTAGE***
  - ***MANY OTHER SPECIFIC MEASUREMENTS***
- ***AUTOMATIC MEASUREMENT SEQUENCE***
  - ***UP TO 15 MEASUREMENTS***
  - ***AUTOMATIC STOP SEQUENCE***
- ***GO/NO-GO TESTING***
- ***400-ps RISETIME***
- ***100 ps/DIV-to-500 ms/DIV***
  - ***CALIBRATED SWEEP RANGE***
- ***20 mV/DIV-to-2 V/DIV***
  - ***CALIBRATED VOLTAGE RANGE***

The Types S-3110 and S-3111 Model 651A Automated Measurement Systems are dynamic measurement systems intended for measuring the performance of active devices under simulated operating conditions. They are designed to test integrated circuits, transistors, diodes, circuit modules, circuit boards, and sub-assemblies in all segments of the electronic industry. These systems can sequence through up to 15 measurements at a rate of 100 measurements per second. High and low measurement limits may be programmed and the system will stop on any combination of limits (high, go, low) if desired. A foot switch permits remote operation of the advance and reset program functions.

These systems feature up to 15 measurement programs. Each measurement program has a card that is easily programmed by inserting diodes between the proper clips. Typically 15 to 20 diodes will provide the necessary program conditions. They are inserted with an easy-to-use tool.

The following instruments comprise the Type S-3110 Model 651A: Type R568 Oscilloscope with the Type 3T6 Programmable Sampling Sweep and Type 3S6 Programmable Sampling [illegible] two Type S-3 Sampling Heads, Type R230 Digital Unit, Type R241 Programmer, 44-inch high equipment rack, two blank panels, a fixture drawer, two probe choppers, and a foot switch.

Automated Measurement System

S-3110
MODEL 651A

The fixture drawer contains mounting for the Type S-3 Sampling Head Probes, pulse generator inputs through 50-Ω coax, probe power supply inputs, and 14 buffered fixture lines through a 56-pin circuit board connector. An unwired test fixture card, part no 670-1016-00, and a performance check-out card are included as standard accessories.

The Type S-3111 Model 651A is identical to the Type S-3110 Model 651A with the exception that a pulse generator and power supply are added in place of the two blank panels. The pulse generator is a Tektronix Type 115 MOD 814R, mounted in a rack adapter that permits adding another pulse generator at a later date. The power supply is a Power Designs, Inc. Model 2005 mounted in a rack adapter that permits adding another supply at a later date.

The Tektronix Type 115 MOD 814R features output connectors on the rear panel, 10-ns to 100-μs separate and variable risetimes and falltimes, 100-ns to 10-ms pulse periods, 50-ns to 500-μs pulse delay or burst time, 50-ns to 500-μs pulse width, +5 V to —5 V DC offset and up to ±10 V amplitude into 50 Ω.

The Power Designs, Inc. Model 2005 Precision Power Source features a digitally-selected operating range from 0 to 20 V, 0 to 500 mA; accuracy is within 0.1% ±1 mV; load and line regulation is less than 0.0005% or 100 μV; noise and ripple is less than 100 μV, P-P; and stability is less than 100 μV drift per 8 hours.

CHARACTERISTICS

DUAL-TRACE VERTICAL AMPLIFIER

The included 10X probe attenuators must be used with the included probe choppers. Vertical characteristics are stated with the 10X attenuator.

Voltage measurements are from 20 mV/div to 2 V/div (8 div full scale) accurate within 3%.

Bandwidth is equivalent to DC to 875 MHz.

Risetime is less than or equal to 400 ps.

Input characteristics are 1 MΩ paralleled by 2 pF.

Programmable DC offset is from +9.95 V to —9.95 V in 50-mV steps.

TIME BASE

Programmable sweep time/div is from 100 ps/div to 0.5 s/div in 30 calibrated steps, accurate within 3%.

Programmable digital delay range is from 0 to 999.9 μs in increments of 100 ps, 1 ns or 100 ns, depending on the sweep time/div.

Automatic triggering eliminates the need for trigger adjustments over a wide range of trigger amplitudes, shapes and repetition rates. Automatically triggers on signals of 100 mV to 500 mV amplitude over a frequency range from DC to 100 MHz.

PROGRAMMER

Programs up to 15 measurements. Test modes include automatic sequence of up to 15 measurements, manual or external program sequence through 15 measurements or single measurement operation. Out-of-limits measurements can stop the automatic sequence if desired. Each program has one program card with 159 bits that are selected by inserting diodes between the proper clips. Typically 15 to 20 diodes will provide the necessary program conditions. A foot switch provides remote operation of the Programmers advance and reset functions.

DIGITAL UNIT

Units of measure are read out in V, mV, ns, μs, ms, s.

Numerical readout is from —3999 to +3999.

Programmable measurement limits are from —3999 to +3999.

Data output is in parallel BCD code, 29 lines, (1, 2, 4, 8; true = ground, false = +12 V).

DISPLAY UNIT

CRT display is 8 x 10 cm with P31 phosphor.

Calibrator provides 100 kHz accurate within 0.05%, and approximately 1-kHz signals; amplitudes of 0.5 V and 5 V P-P within 2% into ≥100-kΩ load, or 50 mV and 500 mV P-P within 2% into a 1% 50-Ω load.

FIXTURE DRAWER

The fixture drawer provides in one convenient location the input and output facilities of the system. The drawer is 7 inches deep and provides the following facilities: mountings for 2 sampling heads, 2 probe power connections for FET probes (probe power supplies are mounted inside main cabinet), 2 sets of pulse generator trigger and output connectors, 3 sets of power supply output connectors, 2 signal lines, a 36-pin connector which provides probe chopper drive lines, an unwired fixture card, and a connector for the foot switch.

POWER REQUIREMENTS

105 V to 125 V or 180 V to 272 V, 48 Hz to 66 Hz, ≈340 watts (S-3110 Model 651A) ≈500 watts (S-3111 Model 651A) at 115 V and 60 Hz. Rear panel selector on each instrument provides rapid accommodations for six line-voltage ranges.

DIMENSIONS

The Type S-3110 Model 651A is 44 inches high, 23 inches wide and 27½ inches deep. Approximate shipping weight and dimensions are as follows: 443 lb, 54 inches high, 31 inches wide and 36 inches deep. Instruments are mounted on slide-out tracks and individually can be pulled out, tilted and locked in any one of seven positions for convenient access. The Type S-3111 Model 651A is identical to the Type S-3110 Model 651A in dimensions; shipping weight is ≈460 lb.

TYPE S-3110 AUTOMATED MEASUREMENT SYSTEM MODEL 651A $14,000

TYPE S-3111 AUTOMATED MEASUREMENT SYSTEM MODEL 651A $16,000

INPUT/OUTPUT PANEL

In the Type S-3110 and S-3111 Automated Measurement Systems the fixture drawer is replaced by an input/output panel and empty drawer. The input/output panel provides mounting for the Type S-3 Sampling Heads, a trigger input connector, power supply output connectors, pulse generator output and trigger input connectors, and a program connector that has 14 program lines available for programming peripheral equipment plus the necessary lines for operating the probe choppers.

TYPE S-3110 AUTOMATED MEASUREMENT SYSTEM $13,150

TYPE S-3111 AUTOMATED MEASUREMENT SYSTEM $15,150

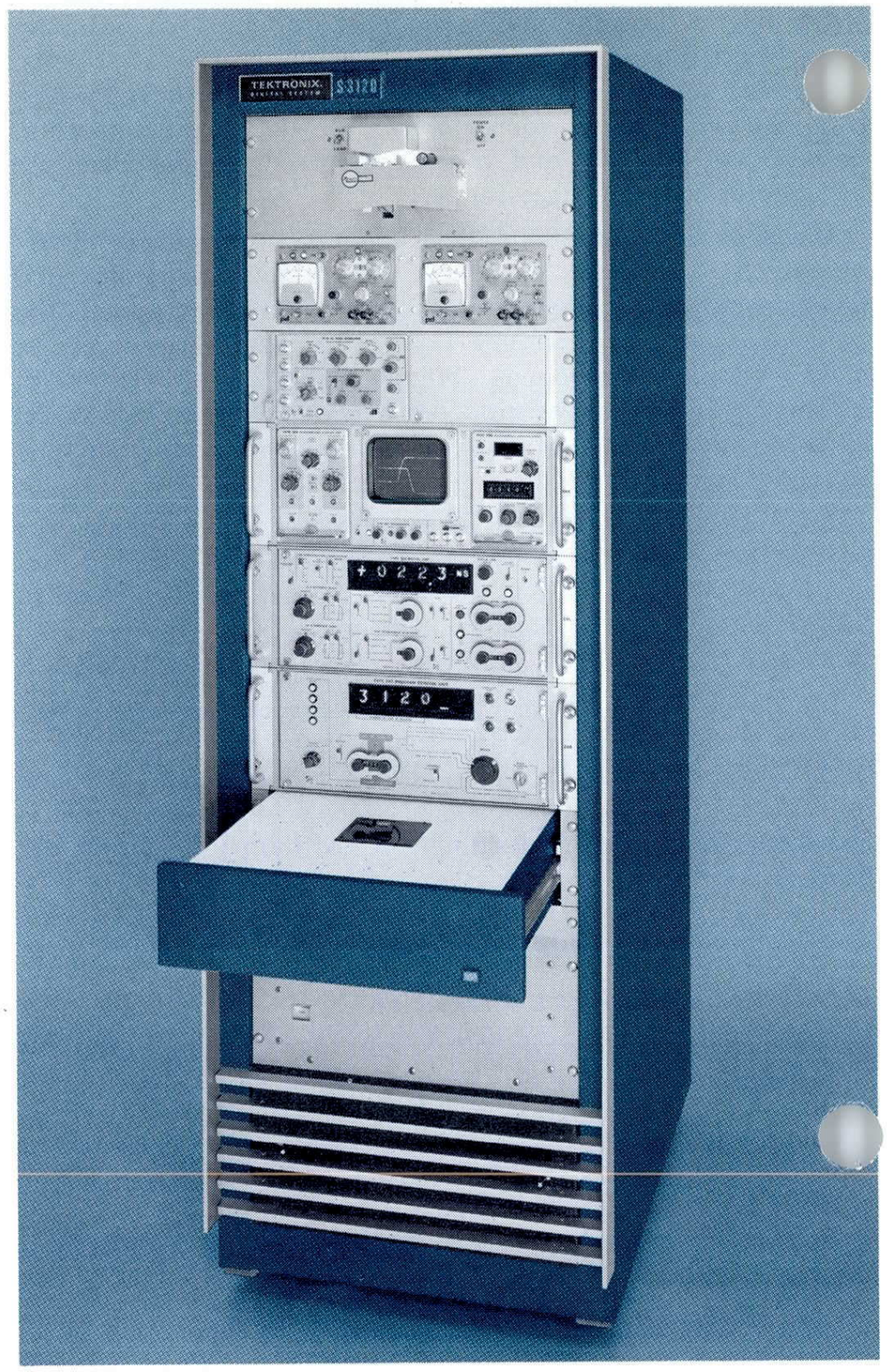
Automated Measurement Systems are available with different Sampling Heads featuring up to 25-ps risetimes, and data recording options. Consult your Field Engineer, Representative or Distributor for further information.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Automated Measurement System

S-3120

- ***DYNAMIC MEASUREMENTS***
  - ***PULSE RISETIME AND FALLTIME***
  - ***PULSE WIDTH AND PERIOD***
  - ***PROPAGATION DELAY AND STORAGE TIME***
  - ***PULSE AMPLITUDE AND SATURATION VOLTAGE***
  - ***MANY OTHER SPECIFIC MEASUREMENTS***
- ***DIAGNOSTIC TESTING***
- ***100 MEASUREMENTS PER SECOND***
- ***1600-MEASUREMENT STORAGE***
- ***400-ps RISETIME***
- ***100 ps/DIV-to-500 ms/DIV***
  CALIBRATED SWEEP RANGE
- ***20 mV/DIV-to-2 V/DIV***
  CALIBRATED VOLTAGE RANGE
- ***MANUAL POWER SUPPLIES***
- ***MANUAL PULSE GENERATORS***



The Type S-3120 Automated Measurement System is a dynamic measurement system intended for measuring the performance of active devices under simulated operating conditions. It is designed to test integrated circuits, transistors, diodes, circuit modules, circuit boards and sub-assemblies in all segments of the electronic industry. Typical areas of application are found in production testing, QC, incoming inspection and preproduction testing.

The S-3120 is intended for use in measurement areas where the power supply voltages and pulse parameters do not require programming. It is not necessary to program pulse generators and power supplies when testing large quantities of devices of a single family that require the same input pulse characteristics, power supplies and logic voltages.

The Type S-3120 can sequence through measurements at a rate of more than 100 measurements per second. The Disc Memory stores a library of up to 1600 independent measurements and permits sorting and classifying devices with diagnostic test routines. The Disc Memory also permits random access to a library of 1600 measurements, permitting a computer or other control device to have complete control over the test measurement. The computer can make calculations from the test data and use the Disc Memory for further measurements and sorting at the maximum test rate.

The following instruments comprise the Type S-3120: Type R568 Oscilloscope with the Type 3T6 Programmable Sampling Sweep and the Type 3S6 Programmable Sampling Unit, two Type S-3 Sampling Heads, Type R230 Digital Unit, Type R240 Program Control Unit, a Disc Memory, Punched Tape Reader, Type R115 MOD 814R Pulse Generator, two Power Supplies, two Probe Choppers; enclosed in a single-bay cabinet with a pull-out drawer that is used as a test station.

CHARACTERISTICS

DUAL TRACE VERTICAL AMPLIFIER

The included 10X or 100X probe attenuators must be used with the included probe choppers. Vertical characteristics are stated with the 10X attenuator.

Voltage measurements are from 20 mV/div to 2 V/div (8 div full scale), accurate within 3%.

Bandwidth is equivalent to DC to 875 MHz.

Risetime is less than or equal to 400 ps.

Input characteristics are 1 MΩ paralleled by 2 pF.

Programmable DC offset is from +9.95 V to −9.95 V in 50 mV steps.

TIME BASE

Programmable sweep time/div is from 100 ps/div to 0.5 s/div in 30 calibrated steps, accurate within 3%.

Programmable digital delay range is from 0 to 999.9 μs in increments of 100 ps, 1 ns or 100 ns depending on the sweep time/div.

Automatic triggering eliminates the need for trigger adjustments over a wide range of trigger amplitudes, shapes and repetition rates. Automatically triggers on signals of 100 mV to 500-mV amplitude over a frequency range from DC to 100 MHz.

DIGITAL UNIT

Units of measure are read out in V, mV, ns, μs, ms, s.
Numerical readout is from —3999 to +3999.
Programmable measurement limits are from —3999 to +3999.
Data output is in parallel BCD code, 29 lines, (1, 2, 4, 8; true = ground, false = +12 V).

MEMORY AND PROGRAMMING

Storage capacity is 1600 measurements. Programming format is a fixed word length of 48 4-bit characters. Parity of each character is checked for positive parity compliance. Program access time is 17 ms average and can be optimized to approximately 1 ms through minimum-access programming.

PULSE GENERATOR

The Tektronix Type 115 MOD 814R features output connectors on the rear panel, 10-ns to 100-μs separate and variable risetimes and falltimes, 100-ns to 10-ms pulse periods, 50-ns to 500-μs pulse delay or burst time, 50-ns to 500-μs pulse width, +5-V to —5-V DC offset and up to 10 V into 50 Ω, positive or negative.

TWO POWER SUPPLIES

The Power Designs, Inc. Model 2005 Precision Power Source features a digitally-selected operating range from 0 to 20 V, 0 to 500 mA; accuracy is within 0.1% ±1 mV; load and line regulation is less than 0.0005% or 100 μV; noise and ripple is less than 100 μV, P-P; and stability is less than 100-μV drift per 8 hours.

DISPLAY UNIT

CRT display is 8 x 10 cm with P31 phosphor.
Calibrator provides 100 kHz accurate within 0.05%, and approximately 1-kHz signals; amplitudes of 0.5 V and 5 V P-P within 2% into ≥100-kΩ load, or 50 mV and 500 mV P-P within 2% into a 1% 50-Ω load.

TEST STATION

The Test Station is a pull-out drawer that provides the interface between the Type S-3120 and the device under test. All of the inputs and outputs of the Type S-3120 are available on a 56-pin connector and through 50-Ω connectors located in the Test Station. A text fixture containing a socket for the device under test, and the appropriate test circuitry for input and output signals can quickly and easily be inserted into the 56-pin connector and the 50-Ω connectors. This feature permits the test fixture to be easily changed when new devices are to be checked. Two unwired test fixture cards are included with the Type S-3120. They require circuit design and wiring to obtain a proper interface to the device under test. A system performance check-out test fixture card is also included. Consult your Field Engineer, Representative, or Distributor for quotations on wired test fixture cards for specific devices and tests.

POWER REQUIREMENTS

105 V to 125 V, 60 Hz, approx 700 watts at 115 V and 60 Hz. Rear panel selector on each instrument provides rapid accommodation for line-voltage ranges.

DIMENSIONS

The Type S-3120 is 60 inches high, 26 inches wide and 30 inches deep. Shipping weight is ≈500 lb. Instruments are mounted on slide-out tracks and individually can be pulled out, tilted, and locked in any one of seven positions for convenient access.

INSTALLATION

A Tektronix System Specialist installs the Type S-3120. He checks the complete system for proper operation, and assures that it meets or exceeds published specifications.

TYPE S-3120 AUTOMATED MEASUREMENT SYSTEM $32,350

Includes the following instruments in a single-bay rack with a pull-out drawer that serves as a test station: Type R568 Oscilloscope; Type R230 Digital Unit; Type 3S6 Programmable Sampling Unit; Type 3T6 Programmable Sampling Sweep; two Type S-3 Sampling Heads; Type R240 Program Control Unit; Disc Memory; Punched Tape Reader; Type 115 Pulse Generator MOD 814R in rack adapter; two Power Supplies; two Probe Choppers; two unwired test fixture cards; a performance check-out test fixture card; and includes the standard accessories of the above instruments.

PUNCHED TAPE PROGRAMMING ONLY

The Type S-3121 is identical to the standard Type S-3120 with the exception that the Disc Memory is deleted, and programming is accomplished with the Punched Tape Reader. The maximum measurement rate is 5 measurements per second. The Disc Memory can be added to the system at any time.

TYPE S-3121 AUTOMATED MEASUREMENT SYSTEM $25,100

DISC MEMORY PROGRAMMING ONLY

The Type S-3122 deletes the Punched Tape Reader from the standard Type S-3120. The Disc Memory features a maximum measurement rate of 100 measurements per second. The Punched Tape Reader can be added to the system at any time.

TYPE S-3122 AUTOMATED MEASUREMENT SYSTEM $30,900

OPTIONS

TEST FIXTURE CARDS

Additional unwired test fixture cards can be ordered at any time. They require circuit design and wiring to obtain a proper interface to the device under test. The fixture cards mate to the 56-pin connector in the Type S-3120 and have a coaxial connector for the pulse generator input and two probe connectors mounted on the card.

Order 670-1016-00 ..... $25

AUTOMATIC CALIBRATION

The automatic calibration option checks and adjusts, when necessary, the vertical deflection factor (20 mV/div to 2 V/div) and the horizontal sweep rates (1 ns/div to 0.2 ms/div) to within 1%*.

Order 015-0131-01 ..... $3850

TAPE PUNCH

The Tape Punch provides punched tape copies of program data stored in the Disc Memory. The Tape Punch can be ordered installed, when ordering an S-3120.

Tape Punch installed $2800

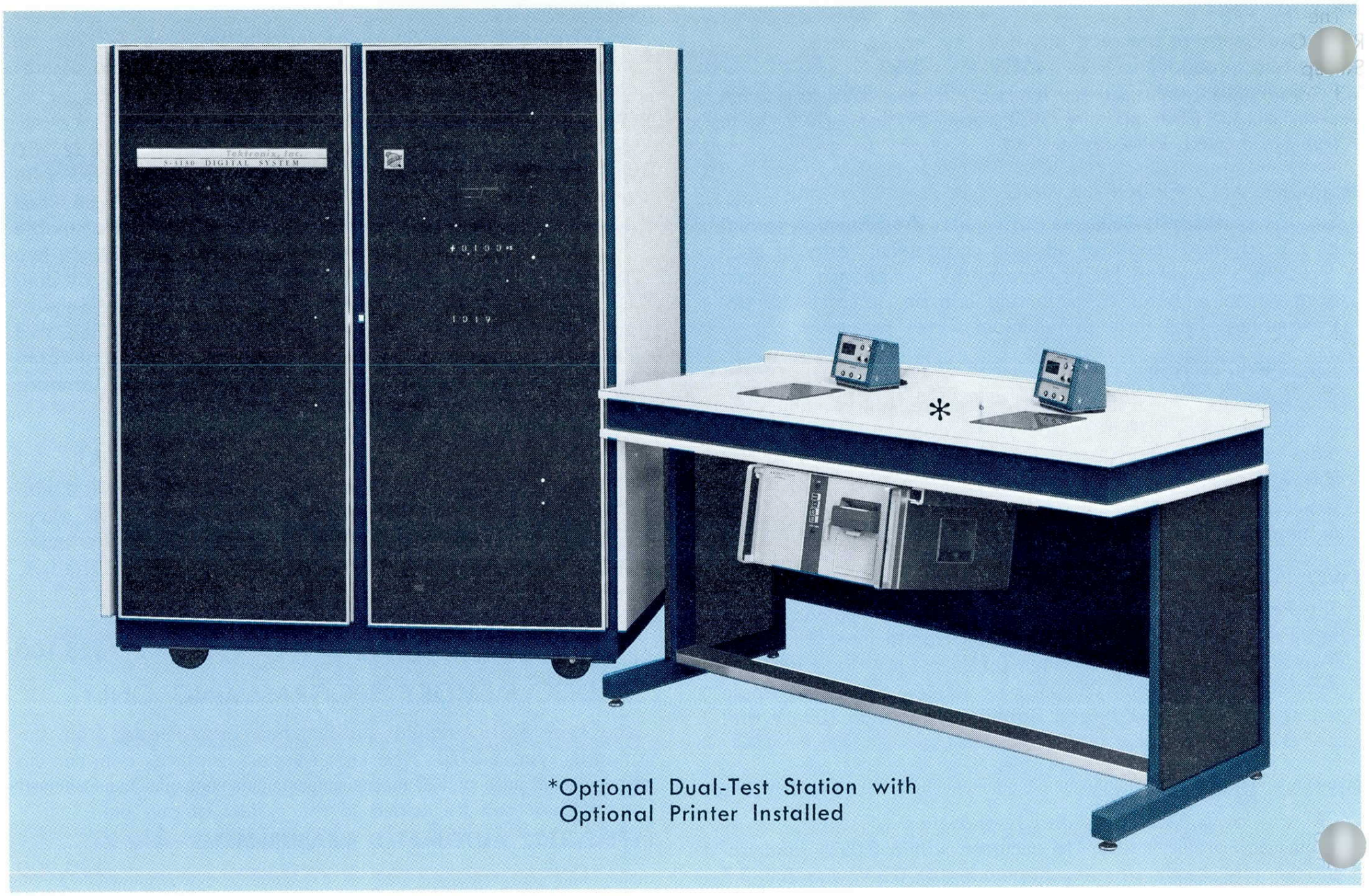
The Type S-3120 is also available with different Sampling Heads featuring up to 25-ps risetime capabilities, and data recording options. It is available in single-bay fully enclosed cabinet with an operator table on one side (similar to Type S-3130). Consult your Field Engineer, Representative or Distributor for additional information.

*Accuracy on 20-mV/div and 50-mV/div positions is within 3%.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

S-3130 Automated Measurement System

S-3130



*Optional Dual-Test Station with Optional Printer Installed

- ***DYNAMIC MEASUREMENT***
  - ***PULSE RISETIME AND FALLTIME***
  - ***PULSE WIDTH AND PERIOD***
  - ***PROPAGATION DELAY AND STORAGE TIME***
  - ***PULSE AMPLITUDE AND SATURATION VOLTAGE***
  - ***MANY OTHER SPECIFIC MEASUREMENTS***
- ***1600 MEASUREMENT STORAGE***
- ***PROGRAMMABLE***
  - ***PULSE GENERATOR***
  - ***POWER SUPPLIES***
- ***100 MEASUREMENTS PER SECOND***
- ***500-ps RISETIME***
- ***PROGRAM BRANCHING FOR DIAGNOSTIC TESTING***
- ***100 ps/DIV-to-500 ms/DIV CALIBRATED SWEEP RANGE***
- ***20 mV/DIV-to-2 V/DIV CALIBRATED VOLTAGE RANGE***

The Type S-3130 Automated Measurement System is a dynamic measurement system intended for measuring the performance of active devices under simulated operating conditions. It is designed to test integrated circuits, transistors, diodes, circuit modules, circuit boards and sub-assemblies in all segments of the electronic industry. Typical areas of application are found in production testing, QC, incoming inspection and preproduction testing.

The Type S-3130 can sequence through measurements at a rate of more than 100 measurements per second. The Disc Memory provides local storage and random access to 1600 independent measurements, and permits sorting and classifying. Diagnostic test routines may also be performed. Provisions are made for a computer or other control device to control the measurement or measurement routine. The computer can make calculations based on test data and employ the Disc Memory for further measurements.

S-3130 Automated Measurement System S-3130

The following instruments comprise the Type S-3130: Type R[illegible] Oscilloscope with the Type 3T6 Programmable Sampling Sweep and Type 3S6 Programmable Sampling Unit, two Type S-3 Sampling Heads, Type R230 Digital Unit, Type R240 Program Control Unit, Type R250 Auxiliary Program Unit, Type R116 MOD 703L Programmable Pulse Generator, four Programmable Power Supplies, a Disc Memory, Punched Tape Reader, Interface Unit, Probe Choppers, and a dual-bay enclosed cabinet with an operator table containing Test Station at one side. Several options for the Type S-3130 are available to satisfy specific measurement requirements.

DUAL TRACE VERTICAL AMPLIFIER

Vertical characteristics are stated with the Type S-3 Sampling Head, signal chopper, and 10X attenuator.

Voltage ranges are from 20 mV/div to 2 V/div (8 div full scale) accurate within 3%.

Bandwidth is equivalent to DC to 700 MHz.

Risetime is less than or equal to 500 ps.

Input characteristics are 1 MΩ within 1% paralleled by 2.4 pF within 10%.

Programmable DC offset is from +9.95 V to —9.95 V in 50-mV steps, accurate within 2% of the programmed value or 50 mV, whichever is greater.

TIME BASE

Programmable sweep time/div is from 100 ps/div to 0.5 s/div in 30 calibrated steps. 1 ns/div to 0.5 s/div accurate within 3%. 100 ps/div to 500 ps/div accurate within 5%.

Programmable digital delay range is from 0 to 999.9 μs in increments of 100 ps, 1 ns or 100 ns, depending on the sweep time/div, accurate within 3%.

Automatic triggering eliminates the need for trigger adjustments over a wide range of trigger amplitudes, shapes and repetition rates. Automatically triggers on signals of 100-mV to 500-mV amplitude over a frequency range from DC to 100-MHz.

DIGITAL UNIT

Units of measure are readout in V, mV, ns, μs, ms, s.

Numerical readout is from —3999 to +3999.

Programmable measurement limits are from —3999 to +3999.

Data output is in parallel BCD code, 29 lines; 1, 2, 4, 8; true = ground, false = +12 V.

MEMORY AND PROGRAMMING

Storage capacity is 1600 measurements. Programming format is a fixed word length of 96 4-bit characters. A parity check is made on each character read into the Type 240 Program Control Unit. Program access time is 17 ms average and can be optimized to approximately 1 ms through minimum-access time programming. 360 parallel program lines are available to various systems instruments.

*Optional Equipment

THREE 40-VOLT PROGRAMMABLE POWER SUPPLIES

Operating ranges from 0 to ±40 V; 500 mA, programmed in 10-mV steps, repeatable within 0.5%, ±3 mV. Output slewing rate is 200 V/ms. Load regulation is within 0.25% or 1 mV, whichever is greater. Line regulation is within 0.02% or 0.5 mV, whichever is greater. Ripple is less than 3 mV RMS.

80-VOLT PROGRAMMABLE POWER SUPPLY

Operating range is from 0 V to ±79.9 V; 200 mA, programmed in 10-mV steps, repeatable within 0.5%, ±3 mV. Output slewing rate is 200 V/ms. Load regulation is within 0.25% or 1 mV, whichever is greater. Line regulation is within 0.02% or 0.5 mV, whichever is greater. Ripple is less than 3 mV RMS.

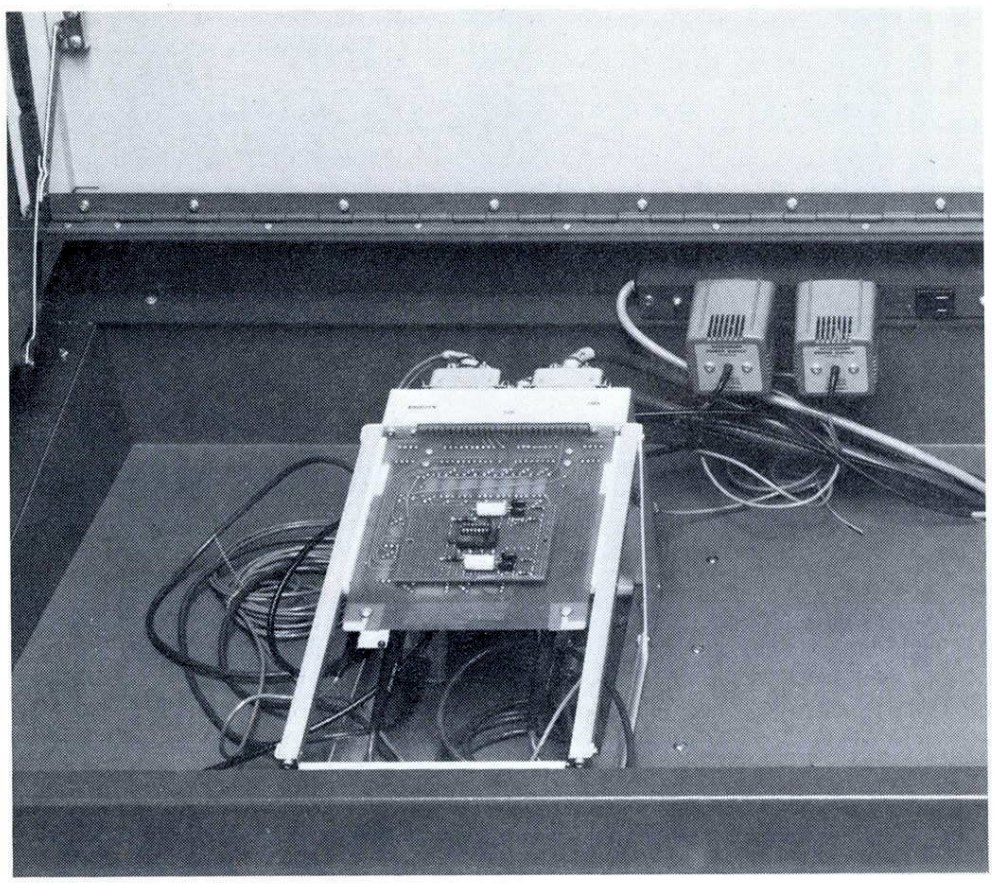
PROGRAMMABLE PULSE GENERATOR

The Type R116 Programmable Pulse Generator is modified (MOD 703L) to include 5 program assembly cards, that provide digital-to-analog conversion of program data. The Type R116 is calibrated with the program assembly cards that are mounted in the Type R250. The input and output connectors of the Type R116 are moved to the rear panel.

All functions of the Type R116 MOD 703L are programmed in the Type S-3130. These functions include: pulse period from 100 ns to 10.9 ms; pulse delay/period from 50 ns to 545 μs; pulse width from 50 ns to 545 μs; pulse amplitude from 0.4 V to 9.9 V; pulse risetime and falltime from 10 ns to 109 μs; pulse DC offset from —4.9 V to +4.9 V.

DISPLAY UNIT

CRT display is 8 x 10 cm with P31 phosphor.
Calibrator provides 100 kHz accurate within 0.5%, and approximately 1-kHz signals; amplitudes of 0.5 V and 5 V P-P within 2% into ≥100-kΩ load, or 50 mV and 500 mV P-P within 2% into a 1% 50-Ω load.



TEST STATION

The Test Station is in the operator table and provides the interface between the Type S-3130 and the device under test. Test inputs and outputs of the Type S-3130, including 32 program lines, are available on a 56-pin connector and through 50-Ω connectors located in the Test Station. A test fixture card that contains a socket for the device under test, and the appropriate test circuitry for input and output signals, can quickly and easily be inserted into the Test Station. This feature permits the test fixture to be easily changed when various devices are to be checked. Two unwired test fixture cards are included with the Type S-3130. They require circuit design and wiring to obtain a proper interface to the device under test. A system performance check-out test fixture card is also included. Consult your Field Engineer, Representative, or Distributor for quotations on wired test fixture cards for specific devices and tests.

DIMENSIONS

The Type S-3130 2-bay cabinet is 60 inches high, 60 inches wide, and 34 inches deep, excluding the operator table. Packed in 2 boxes, the shipping weight is ≈1250 lb. Instruments are mounted on slide-out tracks and individually can be pulled out, tilted, and locked in any one of seven positions for convenient access.

POWER REQUIREMENTS

105 V to 125 V, 60 Hz, approx 1000 watts at 115 V and 50 Hz. Rear panel selectors on each instrument provide rapid accommodation for line-voltage ranges.

INSTALLATION

A Tektronix System Specialist installs the Type S-3130. He checks the complete system for proper operation, and assures that it meets or exceeds published specifications.

FACTORY TRAINING

Tektronix provides an intensive 3-week System Training course on the Type S-3130. Theory of operation, programming, calibration, and trouble-shooting are discussed for each System instrument, as well as the complete System. Classes are held at the Tektronix Industrial Park, Beaverton, Oregon.

TYPE S-3130 AUTOMATED MEASUREMENT SYSTEM $46,700

Includes the following instruments in a dual-bay enclosed cabinet with operator table containing a Test Station: Type R568 Oscilloscope; Type R230 Digital Unit; Type R240 Program Control Unit; Type R250 Program Unit; Type 3S6 Programmable Sampling Unit; Type 3T6 Programmable Sampling Sweep; two Type S-3 Sampling Heads; Type R116 Programmable Pulse Generator MOD 703L; Disc Memory; Punched Tape Reader; four Programmable Power Supplies; two Probe Choppers; two unwired test fixture cards; a performance check-out test fixture card; and includes the standard accessories of the above instruments.

PUNCHED TAPE PROGRAMMING ONLY

The Type S-3131 is identical to the standard Type S-3130 with the exception that the Disc Memory is deleted and programming is accomplished with the Punched Tape Reader. The maximum measurement rate with the Punched Tape Reader is 3 measurements per second. The Disc Memory can be added to the system at any time.

TYPE S-3131 AUTOMATED MEASUREMENT SYSTEM $39,400

DISC MEMORY PROGRAMMING ONLY

The Type S-3132 deletes the Punched Tape Reader from the standard Type S-3130 and maintains the maximum measurement rate of 100 measurements per second. The Punched Tape Reader can be added to the system at any time.

TYPE S-3132 AUTOMATED MEASUREMENT SYSTEM $45,300

OPTIONS

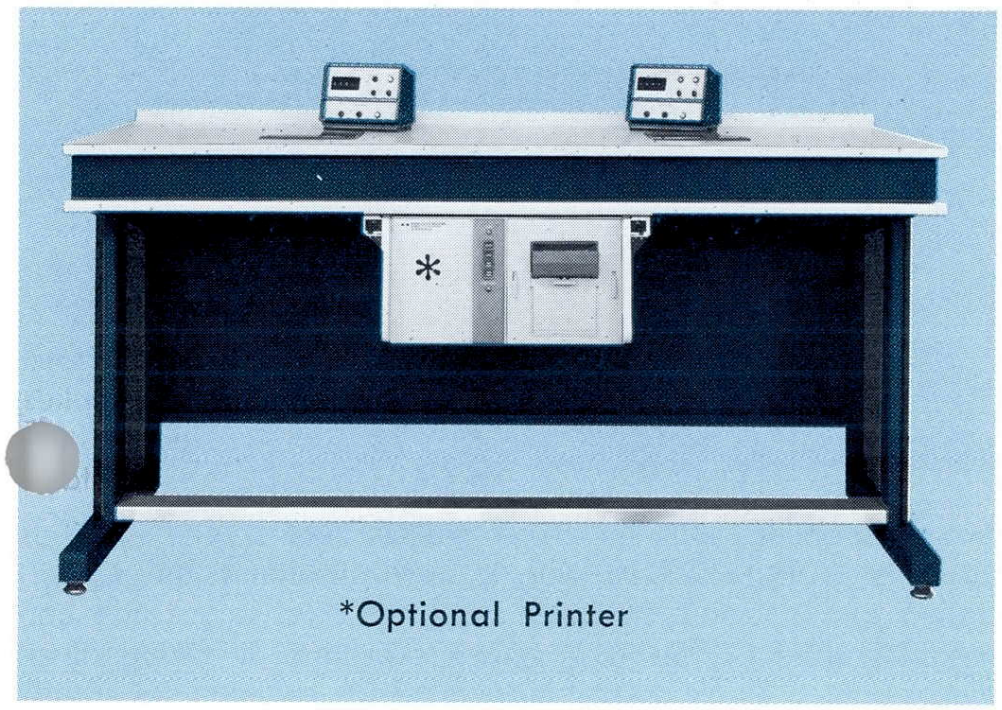
DUAL-TEST STATIONS

Dual-Test Stations are available for the Type S-3130 that permits full use of its measurement speed of 100 measurements per second. This lets the Type S-3130 scan the two test stations, making measurements from either station on command. If the Type S-3130 is making a measurement at one station and receives a start command from the other station, it finishes the first measurement sequence before switching stations.

Each station has separate test fixture cards that permit checking different devices at each station. The station selects its own measurement sequence, indicates the measurement limit results (high, low, go), has a start and reset button, and indicates the station's condition of test (in process or waiting).

Both stations installed in one free-standing 60-inch table $3500

Each station installed in separate free-standing 42-inch tables $3840



*Optional Printer

AUTOMATIC CALIBRATION

The automatic-calibration option checks and adjusts, when necessary, the vertical deflection factor (20 mV/div to 2 V/div) and the horizontal sweep rates (1 ns/div to 0.2 ms/div) to within 1%*.

Order 015-0131-01 ..... $3850

TAPE PUNCH

The Tape Punch provides punched tape copies of program data stored in the Disc Memory. The Tape Punch can be ordered installed, when ordering a Type S-3130.

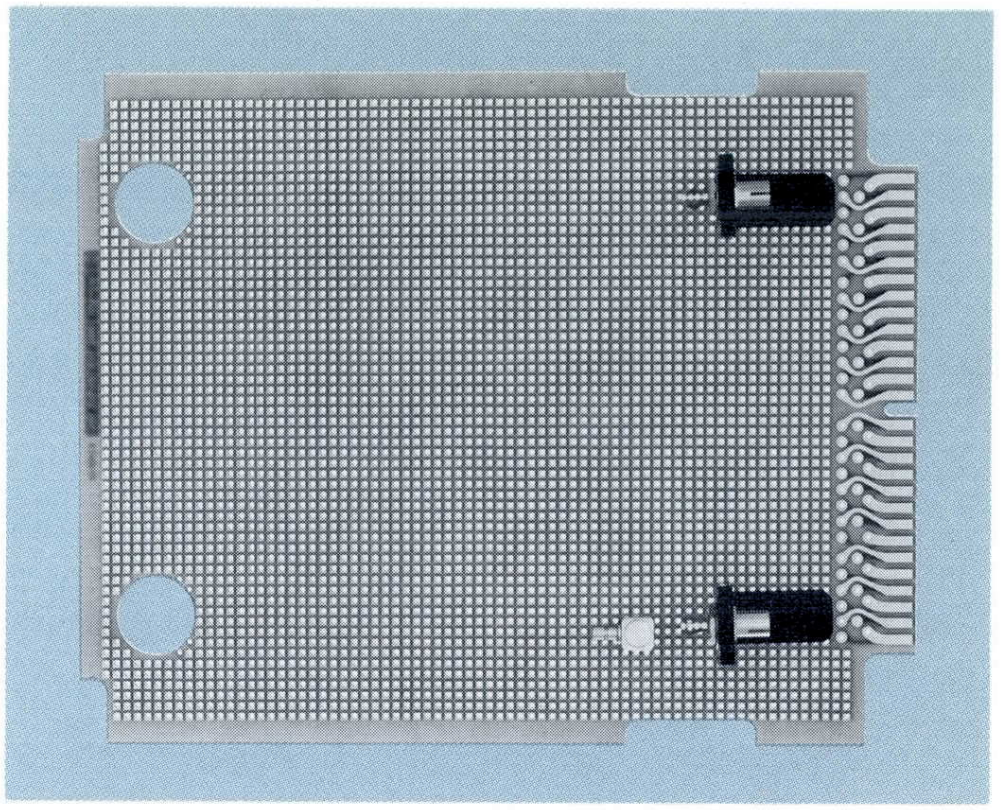
Tape Punch, installed $2800

PRINTER

A printer can be ordered installed, when ordering a Type S-3130. The printer typically supplied has a print format from left to right as follows:

4 columns, test number; next 5 columns, R230 numerical readout; next 2 columns, decimal location; next 2 columns, units of measure; and last column, Go, No/Go results.

*Accuracy on 20-mV/div and 50-mV/div positions is within 3%.



TEST FIXTURE CARDS

Additional unwired test fixture cards can be ordered at any time. They require circuit design and wiring to obtain a proper interface to the device under test. The fixture card mates to the 56-pin connector in the Type S-3130 and has a coaxial connector for the pulse generator input and has two probe connectors mounted on the card.

Order 670-1016-00 ..... $25

ADDITIONAL PROGRAM UNIT/PULSE GENERATORS

An additional Type R250 can be added to the Type S-3130 System. The Type R250 adds 192 program lines that can be used to program additional pulse generators, power supplies, programmable fixtures or other programmable equipment.

The following is a list of common combinations of auxiliary program units and pulse generators. Price includes program unit/pulse generators, installation, programming and checkout. The unused program locations in the R250 contain shift register and standard programming cards.

TYPE R250 MOD 650A/R116 MOD 703L $6,650

TYPE R250 MOD 650A/R293 MOD 703M $5,025

TYPE R250 MOD 650A/R116 MOD 703L/R293 MOD 703M $8,075

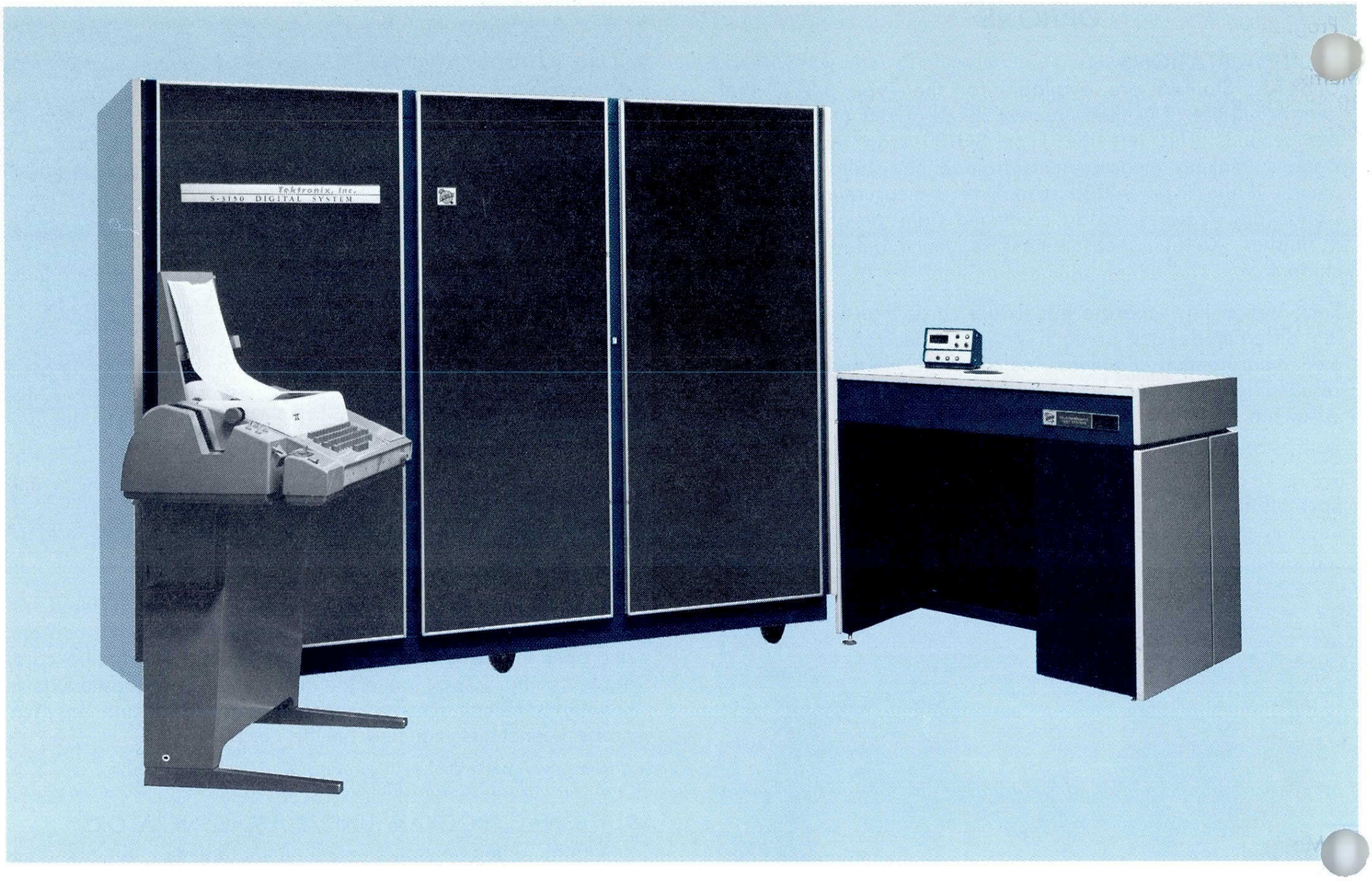
See catalog pages on Type R250 for detailed specifications of Type R250, Type R116 MOD 703L, and Type R293 MOD 703M.

The Type S-3130 is also available with different Sampling Heads featuring up to 25-ps risetime capabilities, and data recording options. Consult your Field Engineer, Representative, or Distributor for additional information.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

NEW

S-3150 Automated IC Measurement System S-3150



- ***16-LEAD INTEGRATED CIRCUITS***
  - ***Measure All Manufacturer Specs In One Socket***
  - ***Dynamic Measurements***
  - ***DC Measurements***
  - ***Functional Tests***
- ***COMPUTER***
  - ***Plain English Programs For Testing***
  - ***Data Acquisition***
  - ***Data Reduction***
  - ***Computer Control Of Test Sequence***
- ***16-PIN PROGRAMMABLE TEST STATION***
  - ***1-ns Measurement Capability***
  - ***1-ns Excitation Capability***
  - ***5-nA Current Measurement***
  - ***100-V Voltage Measurement***
  - ***3 Programmable Loads Per Pin***
  - ***3 Programmable Voltage Supplies Per Pin***
- ***1080 MEASUREMENT STORAGE***
- ***100 MEASUREMENTS PER SECOND***

The Type S-3150 is a high-speed, disc-programmed, dynamic and DC tester for digital integrated circuits. The measurement system is self-contained and once programmed, will perform tests on a go, no/go basis or on a diagnostic basis at rates to 100 measurements per second. A Digital Equipment Corporation, PDP-8/L Computer is utilized for on-line data acquisition, off-line data reduction and in writing programs for the DC and dynamic tester with the interactive software that is supplied with the Type S-3150. The Type S-3150 is basically a Type S-3130 with a new programmable IC test station and a small computer used for data acquisition and program writing. This new system provides: 1. Fixture flexibility—only a single load board need be changed to accommodate most logic families, most changes within a family are under program control (loads, power supplies, and stimuli). 2. DC capability—DC currents and voltages may be measured to within 1% in most cases in the same socket as used for the dynamic measurements. 3. Computer controlled data acquisition . . . . no loss in test rate. 4. A special interactive computer program . . . . generates measurement system programs from the keyboard. It is a plain English program that interacts with the programmer at the keyboard. 5. Use of a disc memory . . . . measurement system may be used for go, no/go and diagnostic testing while the computer is used for batch data reduction or interactive program compilation.

The following instruments comprise the Type S-3150: Type R568 Oscilloscope with the Type 3T6 Programmable Sampling Sweep and Type 3S6 Programmable Sampling Unit; Type R230 Digital Unit; Type R240 Program Control Unit; two Type R250 Auxiliary Program Units; two Type R116 MOD 703L Programmable Pulse Generators; Type R293 MOD 703M Programmable Pulse Generator; Programmable Power Supply (includes 4 voltage and 1 current supply); Disc Memory; Punched Tape Photo Reader; Interface Unit; Computer Coupler; DEC PDP-8/LA (4k memory — ASR33); two DEC Tape Transports; DEC KG-8/L Data Break; DEC DW08 A I/O Conversion Panel; DEC TC01 Tape Auto Control Unit; all mounted in a 3-bay enclosed cabinet with an operator table containing the Programmable Test Station at one side. Included Teletype ASR33 free standing at other side.

NEW

S-3150 Automated IC Measurement System S-3150

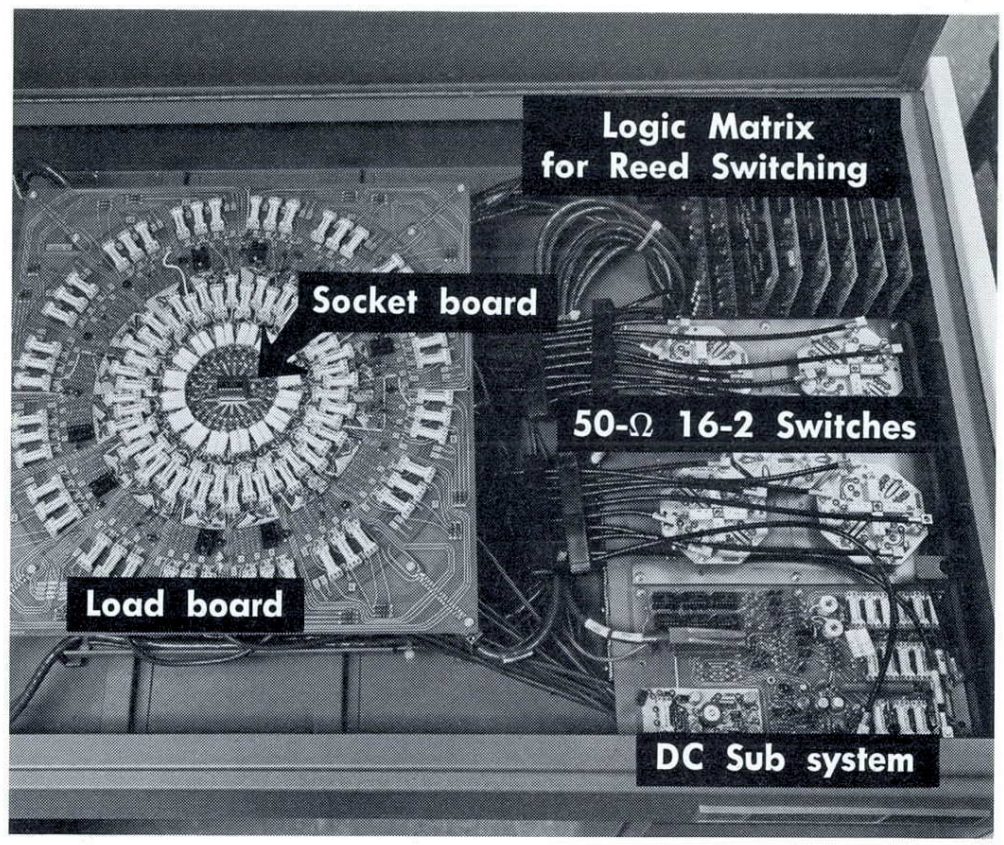
Programmable Test Station includes: one Type R287; four Type 286's, sixteen Type S-3 Sampling Heads, 50-Ω Switching Matrix, DC Subsystem, 7 Control Logic Boards, 2 Load Boards, 10 Socket Boards of types desired, Probe Board, including choppers and required cables.

TEST STATION

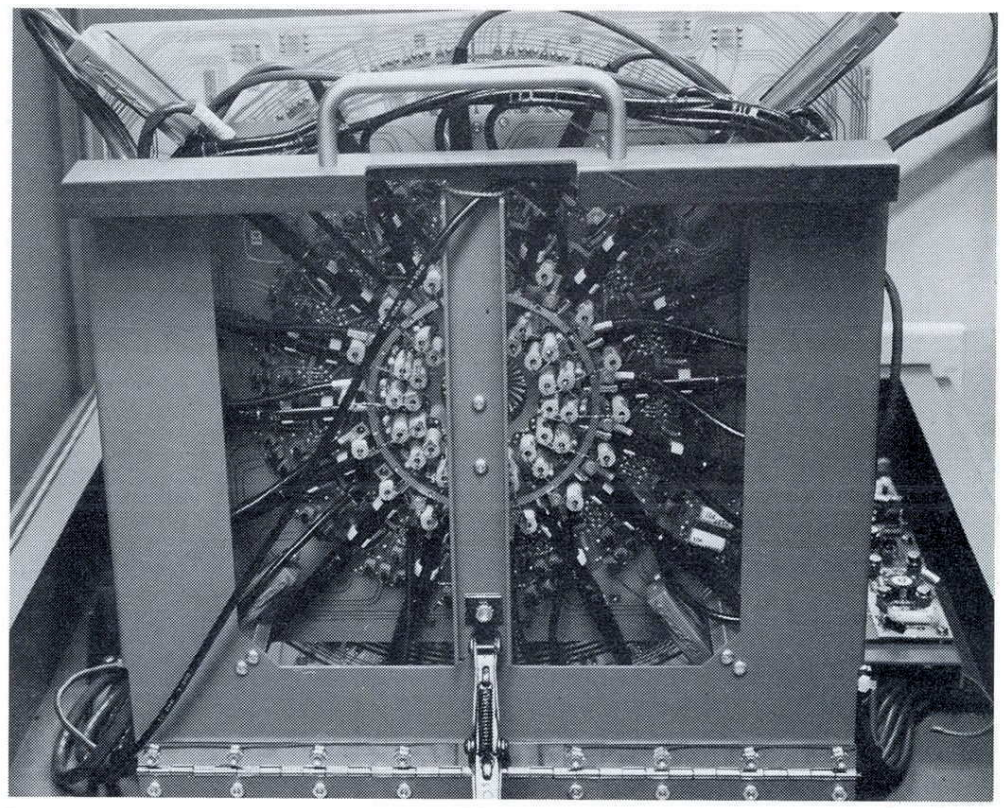
The test station is a free standing console containing a programmable test fixture designed to test digital integrated circuits with up to 16 leads. It is controlled by the measurement system during the test sequence. Each lead of the integrated circuit under test can be independently connected to power supplies, signal sources, load networks, buffer drive circuits, and measurement probes as required. A family of several easily interchangeable plug-on test socket boards allows a variety of socket types to be used and facilitates socket replacement when required. A single load board beneath the test socket holds most of the load networks required for testing a complete family of devices (TTL, DTL, MECL, etc.). Load boards may be interchanged when changing from one family to another or when unusual load networks are required. A small additional board mounted directly beneath the test socket provides mounting areas for load and driver circuits when they must be located very close to the device under test. This mounting area is also useful when leads of the device under test must be wired together or interconnected with load networks.

General Characteristics of the Test Station

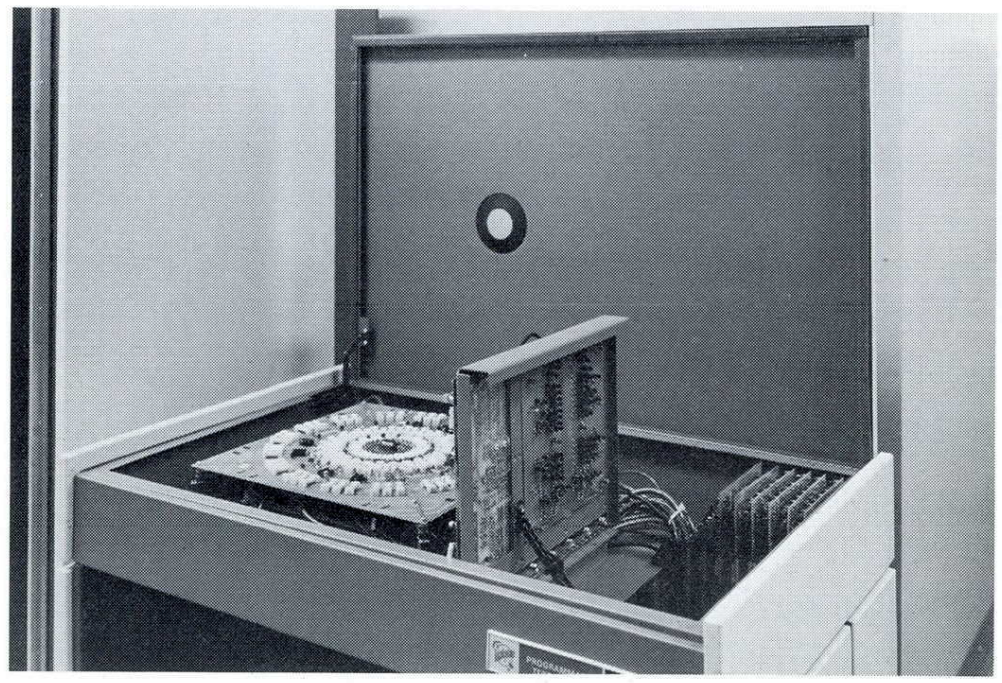
1.	Maximum number of device leads	16
2.	Integrated circuit packages accepted (directly or in Barnes carriers; some TI and Motorola carriers also accepted)	14 and 16 lead dual in-line 10 and 14 lead flat pack; 8, 10, and 12 lead TO-5 pack
3.	Number of programmable loads or buffer drive circuits 48 total	normally 3 for each lead
4.	Number of programmable voltage supplies 4 total	3 directly programable to all leads 1 programmable through load networks
5.	Number of programmable current supplies	1 programmable to any lead
6.	Measurement probes with programmable ×1 and ×10 attenuators	16 Type S-3 Sampling Heads, 1 per lead
7.	Pulse generator inputs 2	each one programmable directly to any lead or to buffer drive circuits
8.	Number of leads selected for each measurement	2



Interior of Test Station



Sixteen High-Impedance Probes mount under Load Board



DC Subsystem raised for Ease in Maintenance

NEW

S-3150 Automated IC Measurement System S-3150

DC Measurement Characteristics of Test Station

1.	Voltage measurement	
	range	±10 mV to ±100 V
	accuracy	within 1% or 5 mV with auto cal within 4% or 5 mV without auto cal
2.	Voltage forcing	
	range	0 V to ±100 V
	accuracy	0 to 40 V range: within 0.2% plus 2 mV 0 to 100 V range: within 0.2% plus 2 mV
3.	Current measurement	
	range	±5 nA to ±100 mA
	accuracy	within 1% or 2 nA with auto cal within 4% or 2 nA without auto cal
	voltage range over which current measurements can be made	−100 V to +100 V
4.	Current forcing	
	range	±1 μA to ±200 mA
	accuracy	0 to 1 mA range: within 0.2% plus 0.1 μA 0 to 200 mA range: within 0.2% plus 10 μA

Dynamic Measurement Characteristics of Test Station

1.	Measurement system risetime including all effects of test fixture environment (from a 25 Ω source)	less than 1 ns
2.	Excitation system risetime including all effects of test fixture environment (not including pulse generator risetime)	less than 1 ns
3.	Distributed capacitance at each lead	less than 15 pF
4.	Voltage measurements	
	range	3 mV to 16 V
	accuracy	within 1% or 1 mV with auto cal within 3% or 1 mV without auto cal
	DC offset range	−20 V to +20 V
	safe overload voltage	100 V peak
5.	Time Measurements	
	Sweep Time/Div	
	range	100 ps to 500 ms in 10 ranges (1-2-5 sequence)
	accuracy	within 3%, (within 1% with auto cal), (100 ps to 500 ps/div within 5%)
	Delay Ranges	
	Time/Div	
	100, 200, 500 ps	0 to 1 μs in 100 ps increments
	1 ns to 1 μs	0 to 10 μs in 1 ns increments
	2 μs to 500 μs	0 to 1 ms in 100 ns increments
	1 ms to 500 ms	no delay available
	High-speed programming	time base equipped with special circuitry which in conjunction with Type R230 Digital Unit resets sweep when measurement is completed or after last memory zone, thus measurement rate is considerably increased, especially with low repetition rate signals and when operating at slower sweep rates

Memory and Programming

1.	Storage capacity	1080 measurements
2.	Measurement word format	144 characters of four bits each (576 bits) plus parity
3.	Test sequences	any length from 1 to 1080 measurements, sequence may be altered by test results
4.	Parity	each character checked for even parity compliance
5.	Program access time	random access 17 ms (average) can be optimized to approximately 1 ms through minimum access time programming
6.	Operating modes	a. transfer test on disc to tape
		b. locate next disc address
		c. read test from disc
		d. read test sequence from disc
		e. read test sequence from tape
		f. examine or modify characters in register
		g. write test in register on disc
		h. transfer tape sequence to disc

Analog Display Unit

1.	CRT display area	8 x 10 divisions, each measured division 1 cm

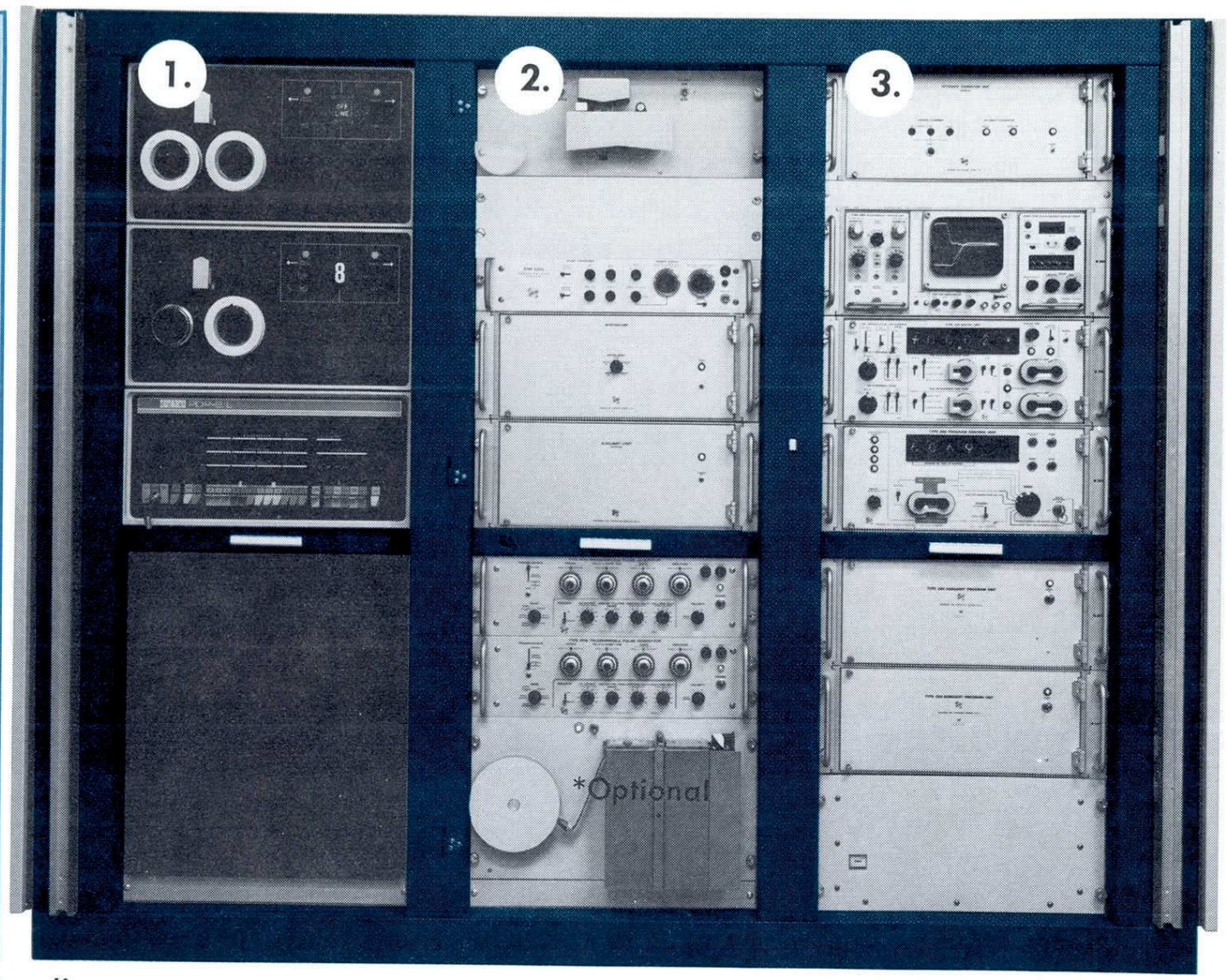
S-3150 Automated IC Measurement System

NEW S-3150

1. Computer and Tape Drives

2. Stimulus and Memory

3. Measurement and Control



Programmable Power Supplies

40 V Power Supplies (3 each)	
operating range	0 V to ±39.99 V programmed in 10 mV steps at up to 400 mA source, 100 mA sink
accuracy	within 0.2% plus 2 mV
100 V Power Supply (1 each)	
operating range	0 V to ±100 V
	programmed in 100 mV steps at up to 100 mA source or sink
accuracy	within 0.2% plus 2 mV
Current Supply (1 each)	
operating range	0 mA to ±199.9 mA programmed in 100 μA steps or 0 mA to ±1.999 mA programmed in 1 μA steps (programmed range selection)
accuracy	within 0.2% plus 10 μA for 0 to ±199.9 mA range, within 0.2% plus 100 nA for 0 to 1.999 mA range
Compliance Voltage	
plus current	−12 V to +88 V
minus current	+12 V to −88 V

Programmable Pulse Generators

Type R116 MOD 703L (2 each)

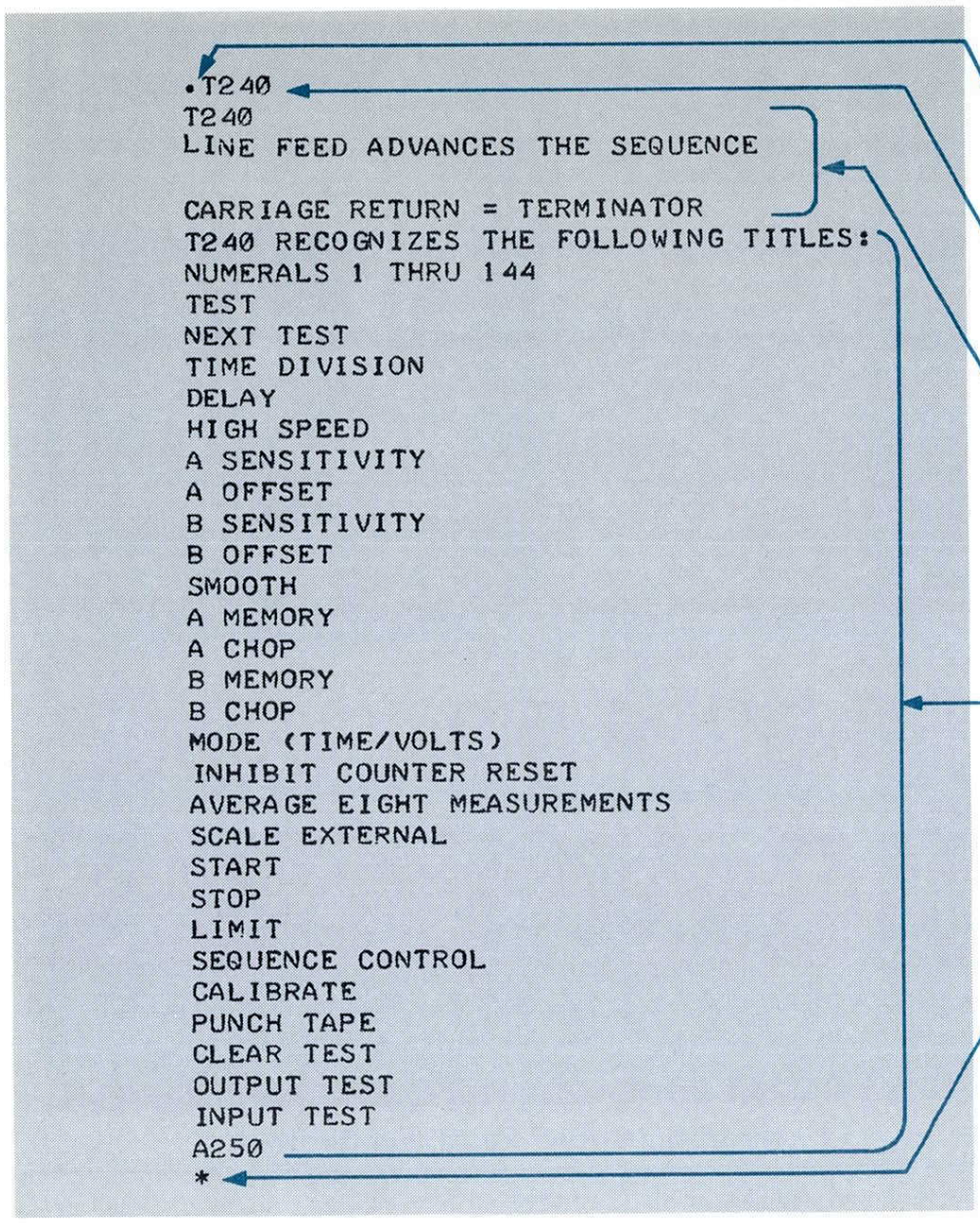
The Type R116 Pulse Generator is modified (MOD 703L) to include 5 program assembly cards that provide digital to analog conversion of program data. All functions of the Type R116 MOD 703L are programmed in the Type S-3150.

Amplitude	±0.4 V to ±10 V in three ranges
Offset (of pulse baseline)	−4.9 to +4.9 V
Rise and Falltime	10 ns to 109 μs in four ranges
Period	100 ns to 10.9 ms in five ranges
Width	50 ns to 545 μs in four ranges

Type R293 MOD 703M

The Type R293 MOD 703M is a Tektronix Type R293 furnished with connectors on rear panel and a program assembly designed to program pulse amplitude and pulse width of the pulse generator.

Risetime	1 ns
Falltime	2.5 ns
Repetition Rate	100 kHz to 10 kHz (not programmed)
Pulse Width	2 ns to 250 ns programmed in 1 ns steps
Pulse Amplitude	6 V to 12 V programmed in 0.5 V steps
Polarity	± (not programmed)
Offset	none



Translator Program (Interactive, Plain English)

- Indicates Tape Monitor Program is in control (printed by computer)
- Typed by operator to call translator program
- Printed by T240 Program, operator then types line feed to get this print out or types carriage return to go to command mode

Auto Calibration Unit

The auto calibration unit contains time reference signal and controlling circuits that calibrate the vertical and horizontal of Tektronix Type S-3150 Digital Measurement System. When programmed and connected as part of the system the auto calibration unit will calibrate the selected deflection factor and the time-base sweep rate. Automatic deflection factor calibration is accomplished by applying precision DC voltages to a vertical amplifier channel, comparing the output against selected limits and, if necessary, automatically adjusting the amplifier gain to produce an in-limits output. Calibration of the time-base sweep rate ranges is achieved in a similar manner. Tunnel diode switching waveforms (at the reference frequency rates) are applied to one of the vertical amplifier channels and the time period between given points is compared against selected limits. If necessary, system sweep rates are adjusted to produce an in-limits output. The time-base sweep ranges of 0.2 ms thru 1 ns may be calibrated by the auto calibration unit, the other sweep ranges may only be calibrated to the accuracy obtained with manual calibration.

Auto Cal Calibration Functions

Type 3S6 (both channels)	10 mV thru 100 mV/div ranges
Tolerance	within 1%
Type 3T6	0.2 ms thru 1 ns/div ranges
Tolerance	within 1%

Computer Interface Unit

The Computer Interface Unit provides an interface between the measurement system and the PDP-8/L Computer. It enables the computer to accept data from the Types 230, 240, and the Tape Reader and to deliver data to the Type 240 and Tape Punch.

Provides:

1. Capability of data logging at a rate compatible with measurement speed of the system without data recording.
2. Provides a useful tool for data reduction with proper software.
3. Can control or direct a test sequence directly as a result of each measurement.
4. Provides for the Tape Reader to be used by the Type 240 or the computer.
5. Allows the computer to share the Tape Punch.
6. Allows the programmer to examine, modify, and replace measurement programs in conjunction with the interactive computer program. The computer and the measurement system can be used as stand-alone units or can be coupled together when it is desired.

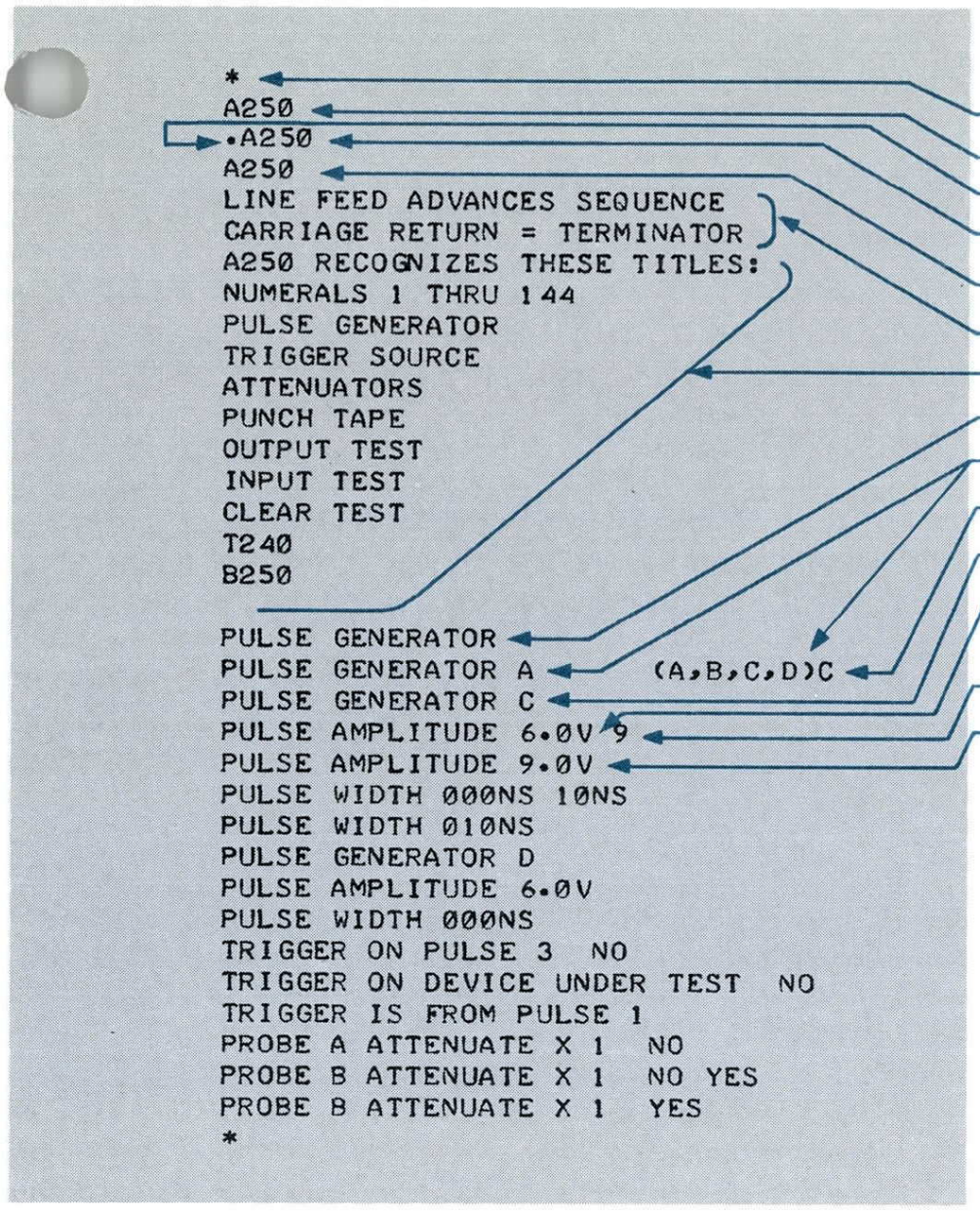
Digital Computer

Tektronix Type S-3150 is currently supplied with a PDP-8/L Programmed Data Processor manufactured by the Digital Equipment Corporation of Maynard, Massachusetts. A basic software package is supplied with the Type S-3150. Although not required in the operation of Tektronix systems, support software furnished by the computer manufacturer including diagnostic programs and instructions is supplied with the computer.

Automated IC Measurement System

S-3150

NEW



Sub-Routine to Program
First R250 in System

- Puts computer in command mode—next entry is typed by operator to call up program
- printed by computer—indicates program is in control
- Typed by operator
- Program echoes back indicating program is in core
- Printed by A250 program, operator then types line feed to get this print out
- First entry typed by operator
- Echoed back by program
- Operator can then type generator he chooses
- Echoed by program
- Line feed by operator provides print out of parameter and value
- Operator can then type modifier to value
- Program echoes modified value

Software

The software packages included with Tektronix computer operated test systems allow test sequences to be written in plain English, test results to be recorded, and test sequences to be transferred to paper tape for permanent storage. Below is a listing of the programs supplied with the Type S-3150.

Translator Program

Allows test sequences to be written in plain English either on-line for immediate debugging or off-line allowing the Type S-3150 to make measurements while other tests are being written. A basic understanding of test instrument terminology and device test requirements are the only prerequisites for use of the program. The program interacts with the operator validating his commands and questioning program errors.

Record Test Result Data Program

Allows test results including device code, device serial number, and test number to be recorded on either magnetic tape or TTY. Data from rejected devices, accepted devices or all devices may be recorded.

Disc Test Sequences to Paper Tape Program

Transfers selected test sequences from the system magnetic disc onto paper tape for permanent storage. The system hardware allows the disc to be loaded from paper tape.

Dimensions

The Type S-3150 is 60 inches high, 84 inches wide, and 34 inches deep, excluding the operator table. Instruments are mounted on slide-out tracks and individually can be pulled out, tilted, and locked in any one of seven positions for convenient access. Approximate shipping weight is 2,500 pounds.

Power Requirements

105 V to 125 V, 60 Hz, approximately 2,500 watts at 115 V and 60 Hz. Rear panel selectors on each instrument provide rapid accommodation for line-voltage ranges. 50-Hz models available.

Installation

A Tektronix system specialist installs the Type S-3150. He checks the complete system for proper operation and assures that it meets or exceeds published specifications. Performance check-out software is included as part of the installation.

Factory Training

Tektronix provides an intensive, four week system training course on the Tektronix Systems.
Theory of operation, programming, calibration, and trouble-shooting are discussed for each system instrument as well as the complete system. Classes are held at the Tektronix Industrial Park, Beaverton, Oregon.

TYPE S-3150 Automated IC Measurement System **$120,000**

TYPE S-3150 MODEL 651B Automated IC Measurement System . . . . . **$ 80,000**

Deletes computer, computer interface unit, and computer software.

Options

Load Boards

Unwired load board, order 018-0034-00 . . . . . $ 900
TTL load board $1,100

Prewired load board for testing series 54/74 TTL Digital Integrated Circuits. Please specify package type (dual in-line or flat pack), type of carrier (if any), and series (Standard, High Speed, or Low Power) to be tested. Consult your Tektronix Field Engineer, Representative, or Distributor for specific Tektronix part number.

Socket Board (23 types available) . . . . . $ 16

Tape Punch

The Tape Punch provides punched tape copies of program data stored in the Disc Memory. The Tape Punch can be ordered installed, when ordering a Type S-3150.
Tape Punch, installed $2,800

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Information Display Reference

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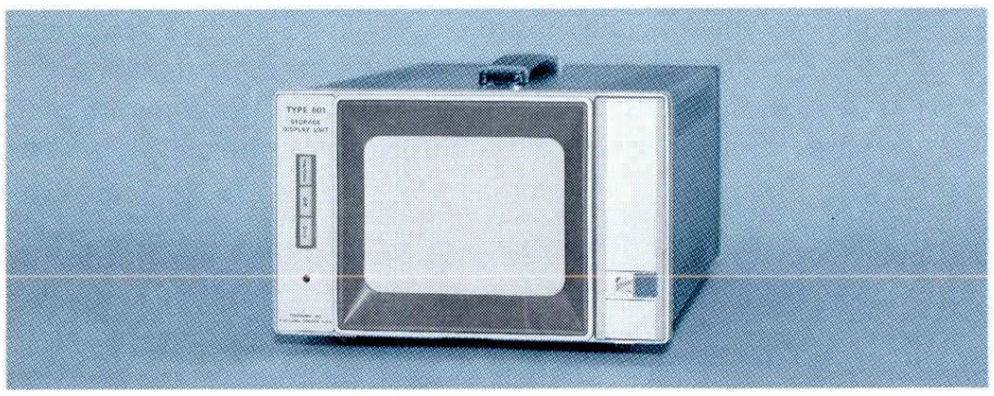
In recognition of the increasing needs for readout devices for computer consoles and remote terminals, Tektronix has devoted considerable time and effort to designing and producing display components which will effectively fulfill these needs. These products cover a wide range of applications including scientific research, process monitoring, production control, retrieval of information necessary for managerial decisions, classroom needs, and computer program development.

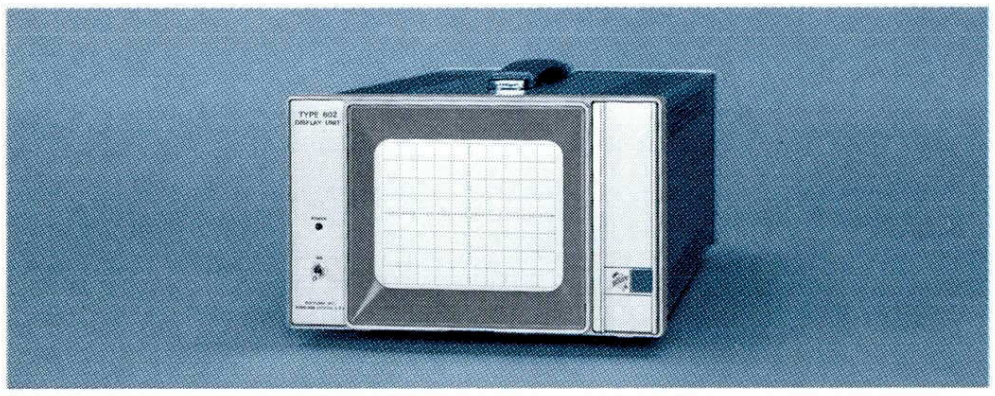
The following is a summary of the Tektronix Information Display Devices. The specification pages contain a more detailed description of the technical aspects and full capabilities of each device.

Type 601 Storage Display Unit



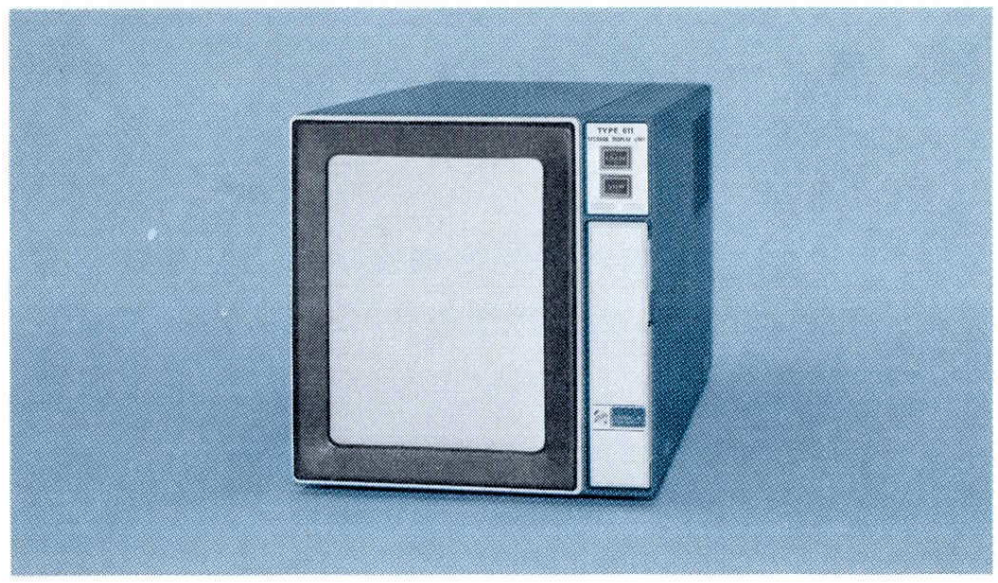
The Type 601 Storage Display Unit provides stored displays of alphanumeric and graphic information from digital computers and other data transmission systems. Costly memory devices for refreshing the information display are not necessary. Resolution is specified at 100 (vertical) and 125 (horizontal) stored line pairs for the 8 x 10 cm display area. X, Y, Z inputs are provided through rear BNC connectors or through the remote program connector.

Type 602 Display Unit



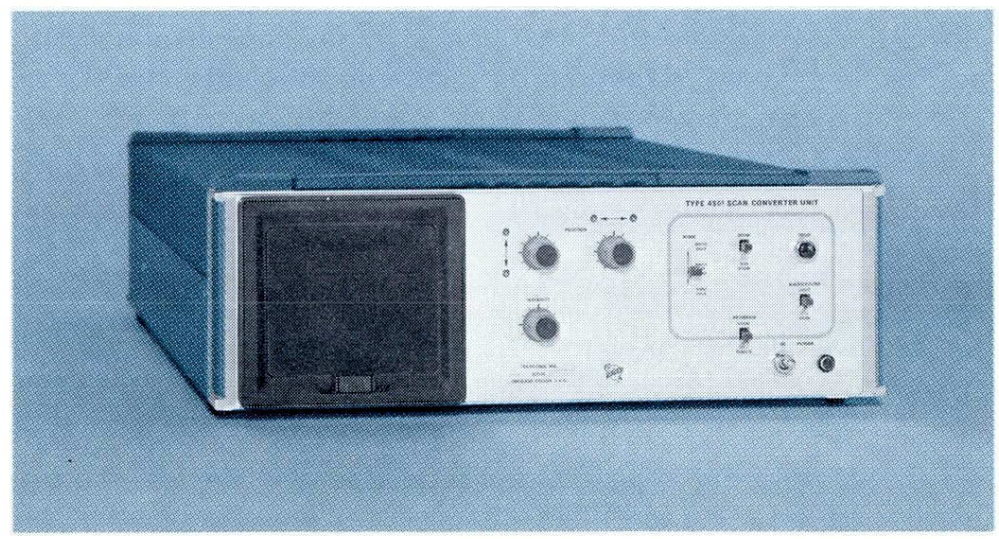
The Type 602 Display Unit is a compact, solid-state refreshed instrument with excellent resolution providing accurate displays of information through X, Y, and Z signal inputs. The Type 602 is particularly suited for applications which require unusually high resolution. Maximum trace width within the 8 x 10-cm display area is 14 mils at 0.5 μA beam current. Typical application areas are: phase shift and frequency ratio measurements, graphic and alphanumeric displays from computers, high-resolution raster displays with intensity modulation and Y-T plots of amplitude versus time.

Type 611 11-Inch Display Unit



The Type 611 Storage Display Unit is designed to function as a readout device for computer terminals. With X, Y, and Z input signals provided by peripheral equipment, this instrument is capable of displaying high-density alphanumeric and comp graphic information without drift or annoying flicker. The scree is 21 cm x 16.2 cm with resolution equivalent to 400 (vertical) and 300 (horizontal) stored line pairs. 4000 characters, 90 x 70 mils in size may be clearly displayed.

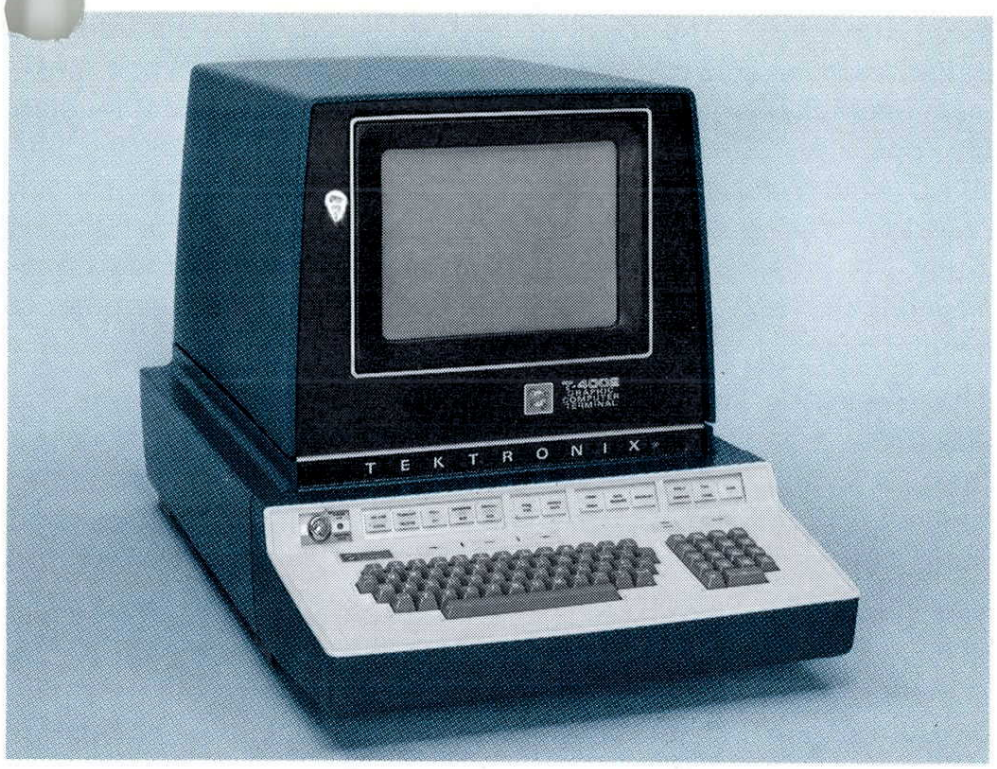
Type 4501 Scan Converter Unit



The Type 4501 Scan Converter Unit is an analog memory device with readout in the form of a composite television signal. Information written on its 5-inch storage tube from a computer or other source is converted to composite video or modulated RF for convenient viewing on large-screen television monitors or receivers. The bright displays achieved in this manner are ideal for individual or group viewing under high-ambient light conditions. A Tektronix, 5-inch rectangular bistable storage tube is utilized as the memory device and provides resoluti equivalent to 100 by 125 stored line pairs. Output fro single scan converter may be looped through a number of monitors for viewing at remote locations. Multiple scan converter outputs can be mixed for color displays.

Information Display Reference

Type T4002 Graphic Computer Terminal



The Type T4002 is a completely self-contained, desk-top information system which provides a high-resolution, flicker-free display with both high-speed complex graphic and high-density alphanumeric capability. Its unique direct-view storage tube eliminates the requirement for a separate refresh memory and minimizes the information rate requirements of the data source. The annoying flicker associated with most refreshed displays is also eliminated. The new data is written only once and data can therefore be sent to the terminal at a convenient rate of 2000 characters per second (AVERAGE).

T4002 Graphic Computer Terminal consists of a display unit, terminal control, character generator, keyboard module, input/output interface and auxiliary unit.

The direct-view bistable storage tube provides most of the economic advantage of this type of system by eliminating costly refresh memory devices. The slower speed allows the use of software for much of the data formatting and data control functions. An analog character generator, with its characteristic of high-accuracy and low-slew rate also contributes to the low-system cost.

The 11-inch, flicker-free display (6-1/2 x 8-1/4-inch screen) accommodates 39 lines of alphanumeric characters of 85 symbols each, permitting more than 3000 characters to be displayed. Resolution is equivalent to 287 x 400 line pairs. Stored information may be erased in less than 0.5 second.

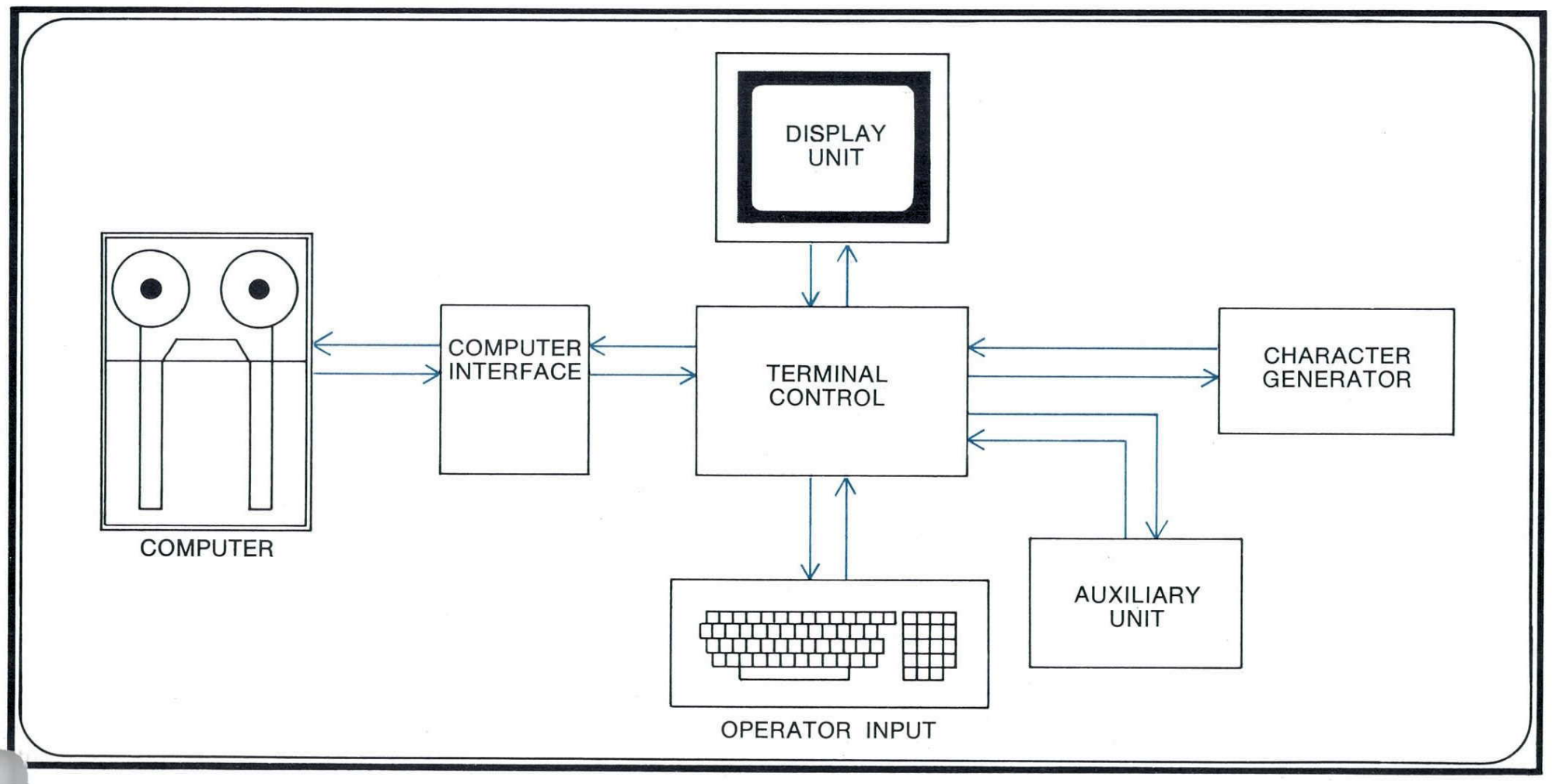
The terminal control provides timing logic, data buffers, interconnection logic, function decoding, line-buffer control, D/A converters and plot logic for the character generator, keyboard and auxiliary module. All the data is routed and priorities determined by the terminal control.

The character generator provides a complete set of USASCII printable characters with both upper and lower case, numerals and special symbols. Two sizes of characters are under program control.

The control panel is designed for ease of operation with panel controls held to a minimum by automatic control functions. The standard keyboard contains keys for 96 USASCII characters and 32 control characters.

To ensure maximum flexibility, the terminal can be interfaced with the following Tektronix Display instruments.

Type 601 ..... (5-inch storage monitor)
Type 602 ..... (5-inch high-resolution monitor)
Type 611 ..... (11-inch storage monitor)
Type 4501 Scan Converter .. (large-screen TV display)



T4002 GRAPHIC COMPUTER TERMINAL BASIC BLOCK DIAGRAM

Information Display Reference

The T4002 is designed to use existing software as much as possible. TTY teletype interface is provided to allow complete compatibility with common existing teletype terminals. Thus, the user who is connected into a time-share service or computer with a regular teletype can connect the terminal with no change in software. Note: There may be a teletype-speed limitation unless the computer interface is modified to eliminate the time delays for TTY teletype. Once this high-speed link is available, however, the full capabilities of the Tektronix Type T4002 may be utilized.

Four modes of display are selectable on the Type T4002: (1) Alphanumeric, (2) Point plotting, (3) Incremental plotting, and (4) Linear interpolation plotting. A fixed grid of 1024 x 742 viewable points are available in any of the four modes.

The following discusses three modes of graphic displays selectable on the T4002. Programs that have been developed in any of the three modes mentioned below will generally be suitable for use with the Type T4002 with only minor modifications.

1. Point Plot: The point-plot mode generates a display by providing a separate address for each point and then plotting it. Although there is no restriction on where the point is placed, this mode can be inefficient because of the amount of data required to draw a graphic display.
2. Incremental Plot: Incremental-plot mode is widely used by mechanical plotters. The display is generated by providing an address for the beginning point. The next point must be adjacent in one of eight directions and may be printed or not printed. This incremental technique saves data bits compared to the point-plot mode.
3. Linear Interpolation: The linear-interpolation mode provides a beginning and ending address. A line is then generated between the two points. This vector-type display allows smoother lines to be drawn since the beginning and ending points are the only points that must be on the fixed grid. Because minimal data is required to draw graphics, this mode is particularly appropriate for transmitting data over phone lines.

One of the greatest advantages of the computer terminal is the fact that programming is made so much easier and quicker. When writing and "debugging" programs, a teletype readout is slow enough that the programmer often loses his train of thought. The mind usually thinks much faster than a teletype can print out program elements. The tremendous speedup of the T4002 with its quick readout allows a rapid input back into the system. Thus, ideas and changes are applied without delay and the effects may be immediately observed. This interactive display capability is particularly important when developing graphics programs, since there is little delay from program development to program observation.

LINE BUFFER

The new Line-Buffer feature of the T4002 Graphic Computer Terminal consists of a one-line, 84-character local memory. This memory is used in conjunction with a 1-cm x 21-cm refreshed area at the bottom of the tube. The information is in alphanumeric form, thus the user can edit the text before sending the information to the computer as a one-line message block. Information may be updated and verified, corrected if necessary, before it is sent to the computer.

Use of the Line-Buffer feature is as follows: The COMPOSE button is pressed to change operation from DIRECT to COMPOSE. At this time, any characters previously entered into the Line Buffer are presented in one line across the bottom of the tube. Information can be changed in one of several manners. The CLEAR button clears the Line Buffer and the cursor reverts to the left-hand edge of the refreshed area (point of entry for next character). The desired text is typed, entered into the buffer memory and appears in the Line-Buffer area. When maximum capacity is reached, the FULL button is lighted to alert the operator. Once the message is complete, pressing the SEND button sends all of the text to the computer as a block of data. The buffer memory is not erased until the CLEAR control is pressed. Therefore, if an error is made during transmission, the text can be recalled and sent to the computer a second time.

This operation offers two advantages. First, text is edited and you know it is correct before you send it; second, it allows you to send a burst of text (i.e., one complete line as opposed to a number of individual characters) which minimizes transmission time.

The Line-Buffer area is also convenient for correcting messages. If the message is not correct as first typed, editing is accomplished as follows: The keyboard is backspaced until the cursor is positioned above the location where a change is desired. Backspacing across a character erases that character from the buffer memory. The character is deleted and the erased part of the text is retyped.

The Line Buffer operation combines many of the advantages of refreshed terminal with the advantages of the direct-view storage tube. This feature is particularly desirable where relatively unskilled operators require information over a time-share network, e.g., parts information and parts drawing applications where a very small amount of input must be accurate.

Another area of Line-Buffer usage is when the terminal is used as a remote "batch" device. Such a use requires updating of information in computer files. The information that is being sent to the computer is the updated information and must be correct. Therefore, it is desirable to compose and verify the entire entry before sending it to the computer.

INTERFACE UNITS

Several interface options are available for the T4002 which increase its efficiency and versatility as a data communications terminal.

Type 4801 and Type 4803 Interface Unit

The Type 4801 Interface Unit is designed to interface the Tektronix Graphic Computer Terminal to the Digital Equipment Corporation's PDP-8 Series of computers with negative input/output buses. The Type 4803 Interface Unit is designed to match the Tektronix Graphic Computer Terminal to the Digital Equipment Corporation's PDP-8 Series of small computers with positive input/output buses. (The following applies to the Type 4801 and Type 4803.) Data is transferred in parallel under Program Data Transfer control of the PDP-8. When receiving input data from the PDP-8, the unit decodes the data, converts the logic, and provides transfer timing information to the Terminal Control. When transmitting output data, the unit changes the Terminal Control data to match the PDP-8 logic and transfers it under control of the computer's timing pulses. Each unit has its own external interconnecting cable wired for direct connection to the PDP-8's Input/Output Bus.

Type 4802 Interface Unit

The Type 4802 is designed to allow the Tektronix Graphic Computer to communicate with devices which transfer data serially in either a full or half duplex mode. It is designed to conform to EIA Standard RS-232-B (October, 1968) which defines the minimum required circuits and electrical signal characteristics for exchanging binary serialized data. The Type 4802 has its

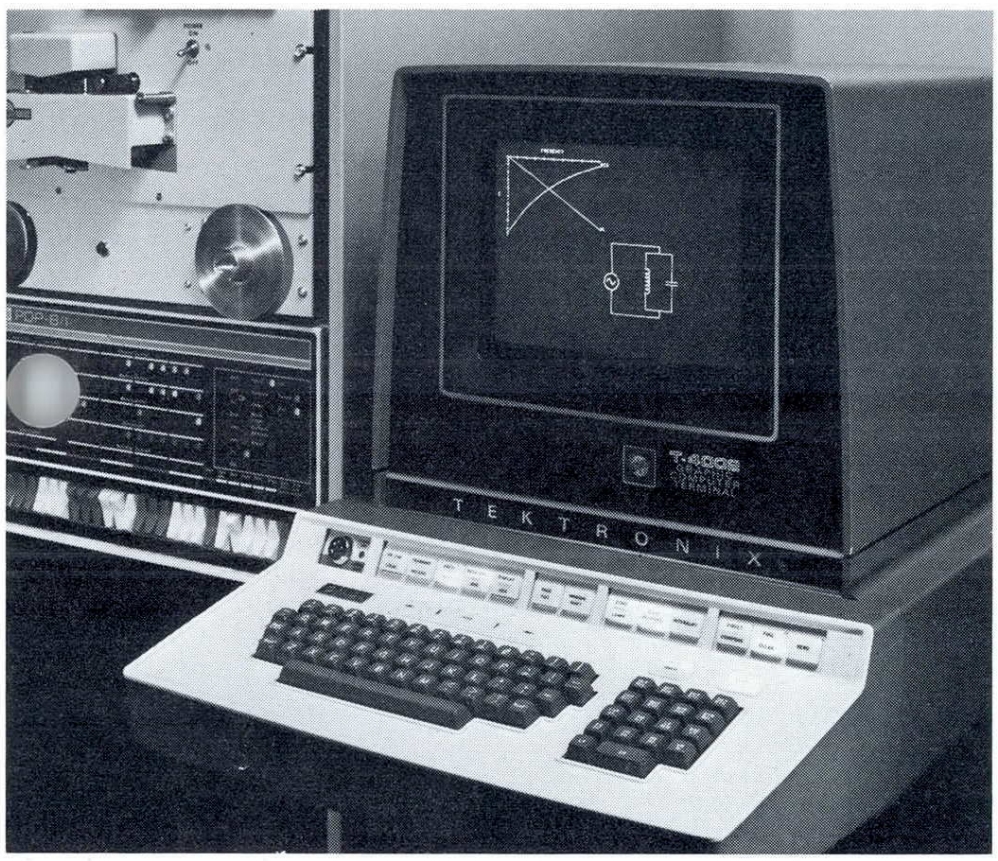
own internal clocks or it can be synchronized with external timing signals. Therefore, it is compatible with synchronous and asynchronous modems. It has its own external interconnecting cable which matches up with many of the most common modems.

The main feature of the Type 4802 is that it gives the Graphic Computer Terminal the capability of working with time-sharing computers over telephone lines. The Type 4802 is wired at the factory to interface with a particular modem specified by the customer. Therefore, the customer, when ordering a Type 4802 must specify a baud transmit and receive rate. The unit he receives will be wired accordingly. Additional timing interface cards may be purchased to adapt the Type 4802 to different modems.

APPLICATIONS

The following are intended to illustrate examples of Type T4002 applications. These brief examples should not be considered as all encompassing. The Type T4002 is a versatile Graphic Computer Terminal capable of solving an extremely wide range of applications.

MATHEMATICAL CALCULATION



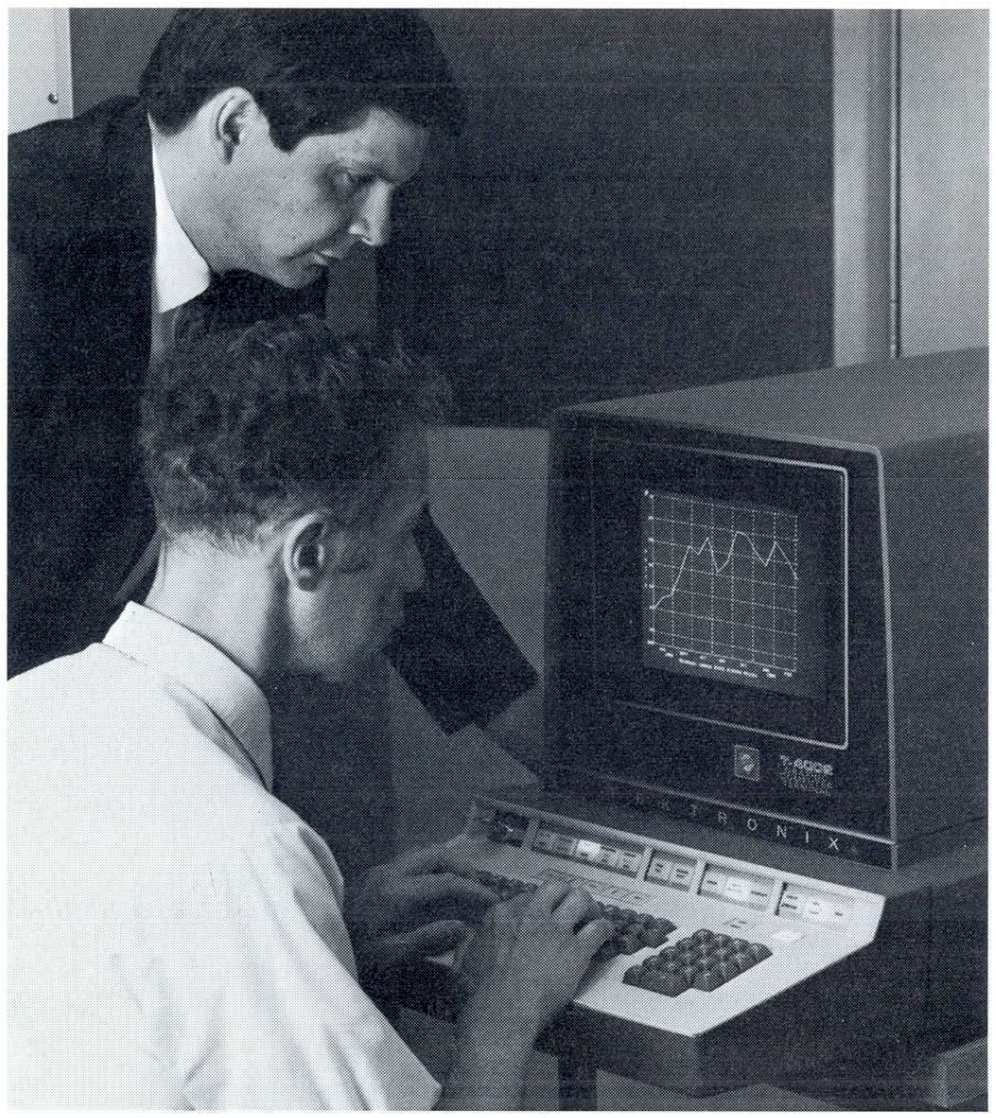
The most common usage of time-sharing terminals today is calculation. With FORTRAN, engineers and scientists can create complex and highly repetitive routines for the computer to handle, insert the variables or parameters, and in a very short time obtain output. This allows exploration of a broad range of possible solutions, and decision-making based on analysis of a large sample or of ALL possible outcomes.

The T4002 is particularly useful in this kind of problem solving when the output is graphic rather than numeric. Certain kinds of problems need to be reduced to graphic form just to enable the user to understand the answer. Other problems lend themselves to easier solution when graphics can be used to reduce a mass of data to a form from which conclusions can more easily be drawn.

INQUIRY PROCESSING

The Entire keypunch, key verify, card handling sequence is eliminated in data processing applications when a display terminal is used for reference, addition, and correction. A typical application would be master file of customers with frequent requests for access to change data or to obtain information on which to take action. A personnel system in a medium or large-size corporation would be another data base which could be economically handled with display terminal access and input. Particular advantage is gained in situations where the customer is "on-line" at the same time as his record is (Customer service Telephone answering).

MANAGEMENT INFORMATION RETRIEVAL



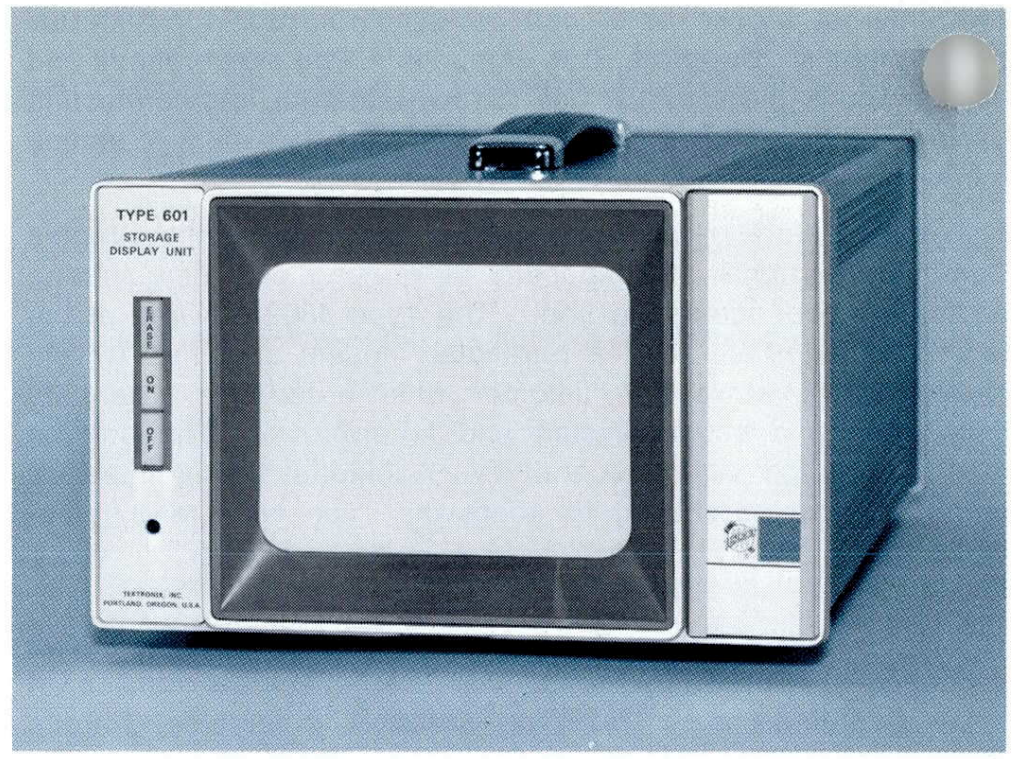
A series of displays, graphs, or charts, with appropriate titling and explanations is very conveniently displayed with the T4002 on the executive's desk top. It can be called up by the executive himself, using simple instructions to the computer. The individual manager can implement his own particular needs for information, with the emphasis on data summary and exception reporting, within a standardized format so that the programming effort does not become prohibitive. Updating of the data for these displays can be done automatically with the updating cycles of the master files.

PROGRAMMING AND DEBUGGING

The T4002 is well suited for use in a time-sharing or multi-programming environment, particularly for on-line conversational program development. The terminal can be connected to a computer with a BASIC support program in its library and the user can begin to write his problem-oriented program. As each line of the program is completed, the computer will examine it against the parameters of the support program and respond on the display screen. The transmission speed and display writing speed of the T4002 make program development and debugging more efficient. When the programmer wishes to review the program written, for whatever reason, he can quickly scan "page after page" in rapid succession. When the program is completed, it can be assigned a place in the program library, located in a high-speed data storage unit, peripheral to the central computer, available for immediate use.

5-Inch Storage Display

601



- ***BISTABLE STORAGE***
- ***1-V FULL-SCALE DEFLECTION FACTOR FOR VERTICAL AND HORIZONTAL DIFFERENTIAL AMPLIFIERS***
- ***REMOTE PROGRAMMING OF DISPLAY FUNCTIONS***
- ***ALL SOLID-STATE DESIGN***

The Type 601 Storage Display Unit provides stored displays of alphanumeric and graphic information from digital computers and other data transmission systems. The Tektronix-developed bistable Storage CRT used in the Type 601 eliminates the need for costly memory devices for refreshing the information display. The built-in vertical and horizontal differential amplifiers permit Y versus T plots up to 100 kHz for remote storage monitor applications. All solid-state modular circuit design insures long-term stable performance.

OPERATING FUNCTIONS

The Erase and Non-Store operating functions are remotely programmable through contacts at the remote program connector on the rear panel. An Erase Interval signal is also provided at this connector. X, Y, Z inputs are provided through rear BNC connectors or the remote program connector. Manual control of Erase and Power On-Off is provided on the front panel. A "ready-to-write" mode is established by erasing the CRT manually or remotely. Remote programming of the Type 601 is achieved by grounding the appropriate contacts at the rear program connector. The Intensity, Focus, Astigmatism, and Operating Level Controls are located behind the front access door for convenience of the operator.

CHARACTERISTIC SUMMARY

VERTICAL (Y) AND HORIZONTAL (X)

CALIBRATED DEFLECTION FACTOR—1-V full-screen deflection X and Y axis.

INFORMATION STORAGE RATE—100 thousand dots per second.

Z AXIS

TURN-ON LEVEL—+1 V or greater.

TURN-OFF LEVEL—+0.5 V or less.

INPUT RC—100 kΩ paralleled by 50 pF.

STORAGE CRT

DISPLAY AREA—Vertical—8 cm, Horizontal—10 cm.

RESOLUTION—Vertical—100 stored line pairs, Horizontal—125 stored line pairs.

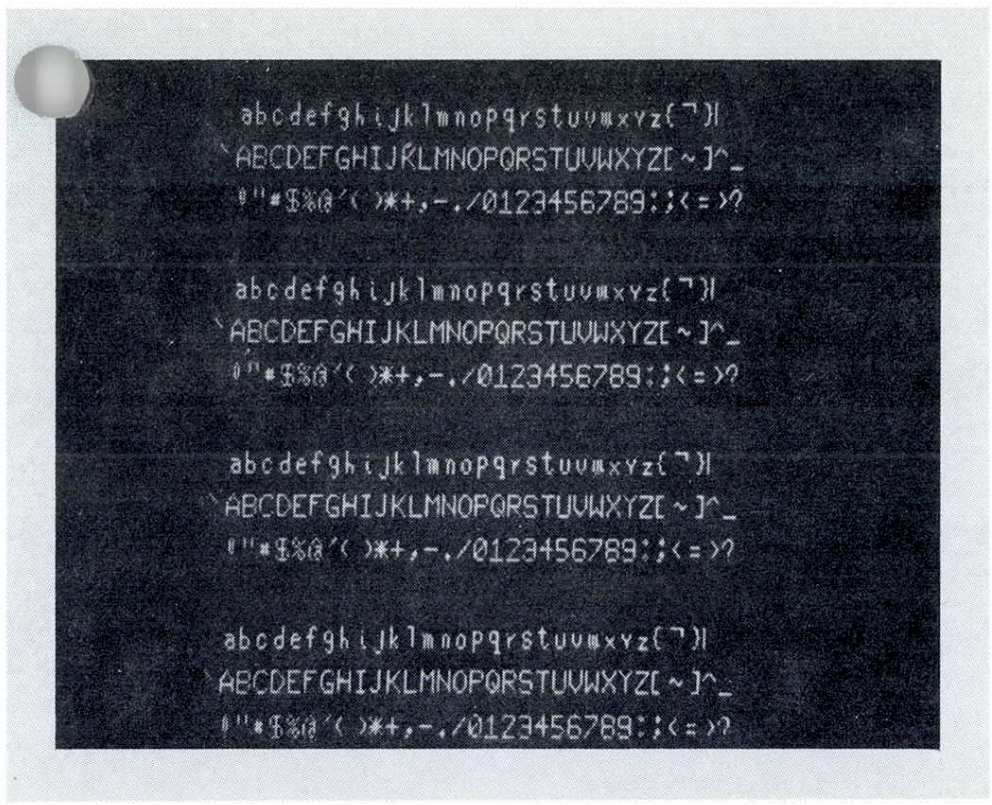
ERASE TIME—200 ms.

DOT WRITING TIME—9 μs.

OTHER

REMOTE CONTROL OF ERASE AND NON-STORE

POWER REQUIREMENTS—90 to 136 or 180 to 272 VAC, 48 to 440 Hz, 57 watts max power consumption.



Stored display of standard ASCII character sets.

VERTICAL AND HORIZONTAL AMPLIFIERS

The X (Horizontal) and Y (Vertical) differential amplifier input circuits are isolated from ground and offer noise-rejection capabilities to minimize noise signals common to the inner and outer conductor of the connecting cables.

DEFLECTION FACTOR

Vertical—1 V for 8-cm deflection, adjustable from 0.75 V to 1.1 V using internal controls.

Horizontal—1 V for 10-cm deflection, adjustable from 0.9 V to 1.1 V using internal controls.

With Attenuation Resistors—Up to 150-V full screen can be obtained by adding attenuation resistors to input circuits.

PHASE SHIFT

Not more than 1° between X and Y up to 100 kHz.

Y-T DISPLAYS

Useful to 100 kHz for displaying waveforms on a Y versus T plot.

INITIAL BEAM POSITION

Positioned by internal adjustment to any point on the screen. Position drift is not more than 1 mm/h after 20-min warm up.

POLARITY

Positive input to the vertical and horizontal inputs moves the beam up and to the right.

LINEARITY

The voltage required to produce a 2-cm deflection at any point on the CRT will not vary more than 5%.

MAXIMUM INPUT VOLTAGE

±50 V combined DC and peak AC.

INPUT RC

100 kΩ paralleled by approx 50 pF.

Z AXIS

The Z-axis on-time should be at least 9 μs to insure good storage of each written dot. The Z-axis pulse should be timed so that the system settling time is completed before unblanking occurs.

INPUT

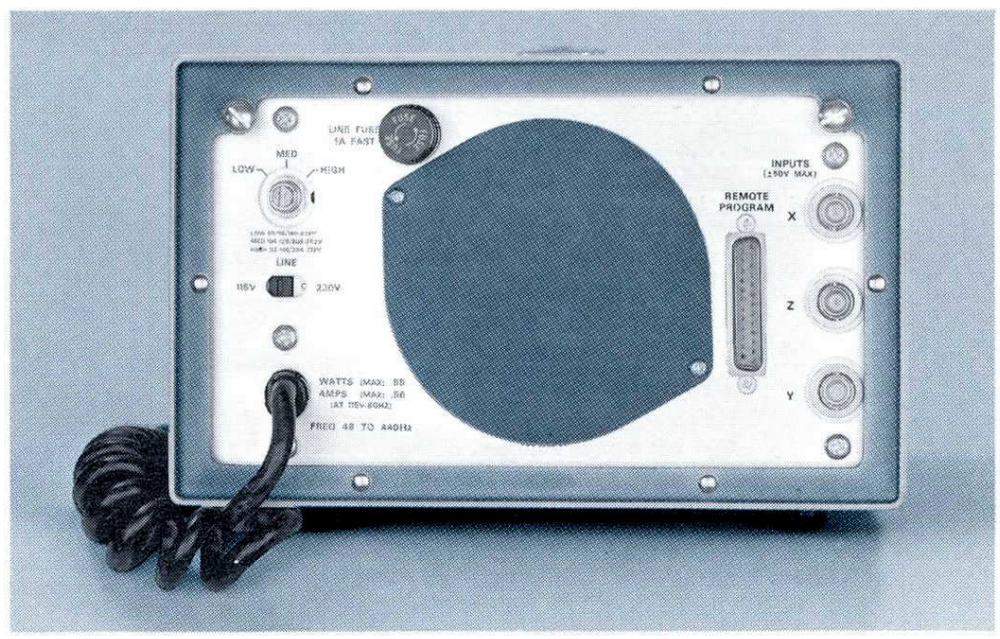
Turn-on level (unblanked) is +1 V. Turn-off level (blanked) is +0.5 V or less. Recommended source impedance for driving the Z-axis is 1 kΩ or less.

MAXIMUM INPUT VOLTAGE

±50 V combined DC and peak AC.

INPUT RC

100 kΩ paralleled by approx 50 pF.



Rear panel of Type 601 Storage Display Unit.

CRT DISPLAY AND STORAGE

TEKTRONIX CRT

5-inch flat-faced bistable storage tube, phosphor similar to P1.

DISPLAY SIZE

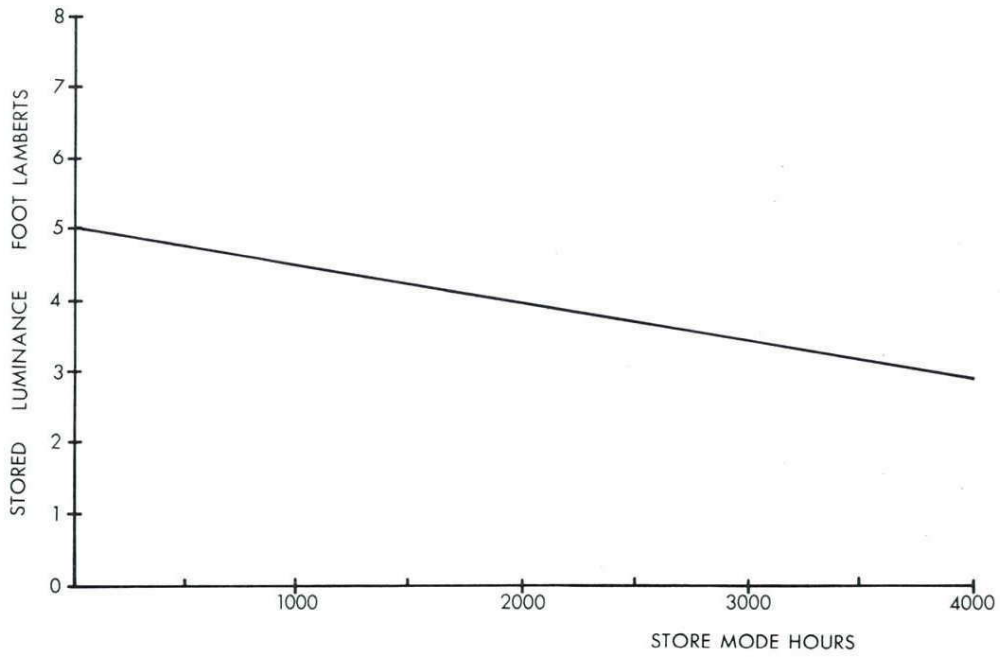
8 cm vertically and 10 cm horizontally.

STORED LUMINANCE

At least 3 foot-lamberts.

CONTRAST RATIO

5:1 or greater.



Typical Aging Trends with Normal Usage

Normal usage is defined as uniform use of all parts of the display area. The Type 601 CRT storage area has improved target stability which extends view time and keeps long-term aging characteristics relatively uniform.

DISPLAY LINEARITY
HORIZONTAL—No more than 5% difference between any two cm.
VERTICAL—No more than 2% difference between any two cm.

RESOLUTION
100 stored line pairs along the vertical axis. 125 stored line pairs along the horizontal axis.

LINE WRITING SPEED (STORED)
At least 5 cm/ms (at specified resolution).

DOT WRITING TIME
9 μs or less is required to write (store) one dot.

INFORMATION STORAGE RATE—100 thousand dots per s.

VIEWING TIME
Up to 15 min recommended. Longer times may be obtained; however, erasure of previously stored information becomes more difficult.

ERASE TIME
200 ms is required to clear screen of stored information.

OTHER CHARACTERISTICS

POWER REQUIREMENTS
90 to 136 VAC or 180 to 272 VAC, 48 to 440 Hz, 57 watts maximum power consumption. Rear panel selector provides rapid accommodation for six line-voltage ranges.

DIMENSIONS AND WEIGHTS

Height	6 in	15.3 cm
Width	8½ in	21.6 cm
Depth	17⅜ in	44.1 cm
Net weight	17½ lb	8.0 kg
Domestic shipping weight	≈24 lb	≈10.9 kg
Export-packed weight	≈30 lb	≈13.6 kg

INCLUDED STANDARD ACCESSORIES
Connector (131-0570-00), connector cover (200-0821-00), two instruction manuals (070-0747-00).

TYPE 601 STORAGE DISPLAY UNIT $1175

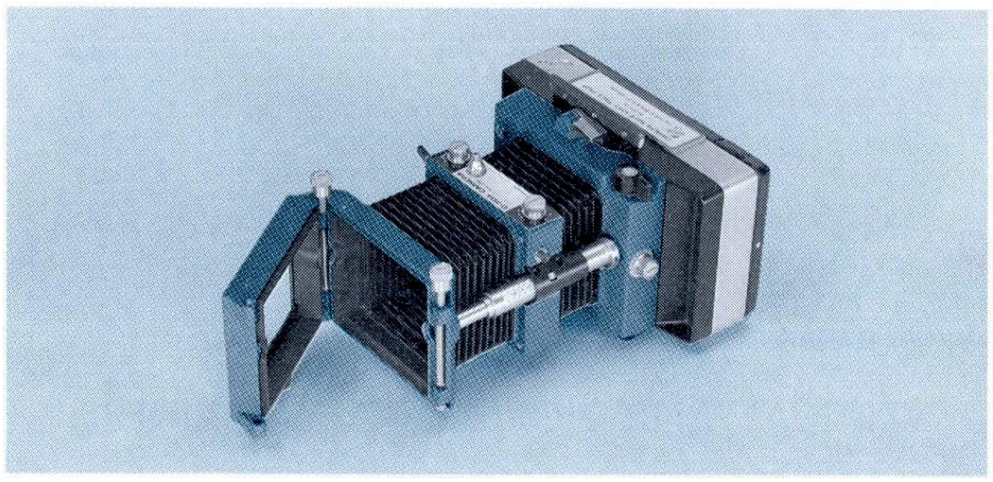
TYPE 601 MOD 146B $1150
Standard instrument, less cabinet, for mounting in rack adapter.

OPTIONAL ACCESSORIES

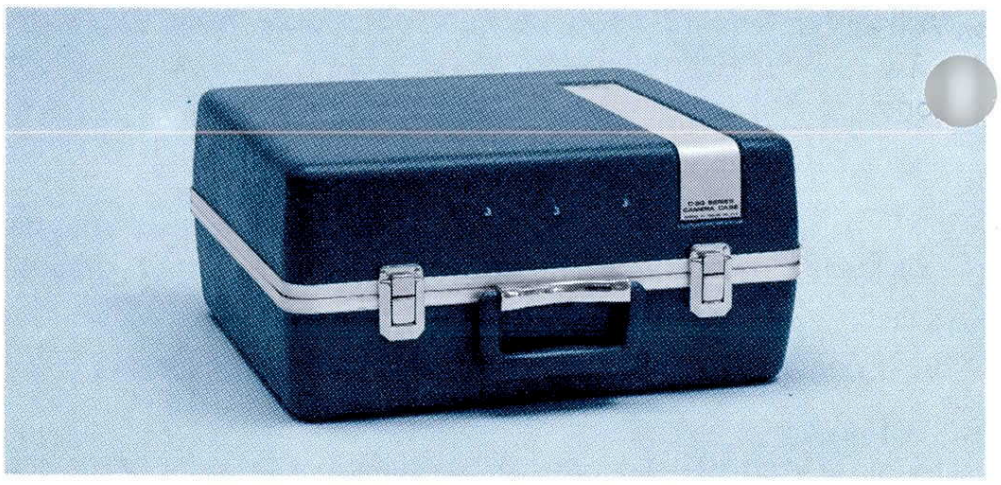
Optional accessories serve to extend the usefulness of the Type 601 in certain applications.

RACK ADAPTER
For mounting two Type 601's side-by-side in a standard 19-inch rack, order 016-0115-02 ..... $ 95

PANEL ASSEMBLY
For covering ½ of rack adapter when only one Type 601 is rackmounted, order 016-0116-00 ..... $ 8



C-30A CAMERA
f/1.9 lens, magnification variable from 1.5:1 to 0.7:1; Polaroid Land* Pack-Film Back, order C-30A-P $480
Type 601 to C-30A Camera adapter, order 016-0248-00 $ 16



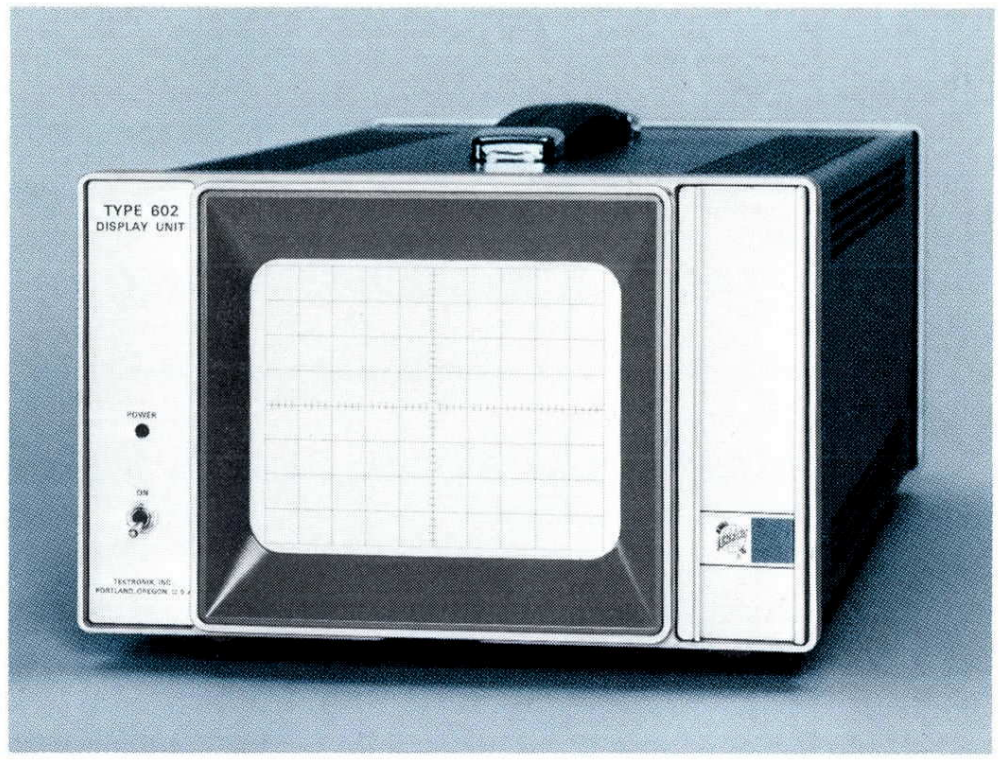
C-30A CAMERA CARRYING CASE
Constructed of heavy-gage, high-impact plastic, has foam-backed, vacuum-formed styrene liner. Holds C-30A Camera, all standard accessories and extra film.
Order 016-0126-00 ..... $ 38

*Registered Trademark, Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

5-Inch, 1 MHz Display

602



- *1-MHz X AND Y BANDWIDTH*
- *100-mV/cm X AND Y DEFLECTION FACTORS*
- *X-Y PHASE DIFFERENCE WITHIN 1° TO 1 MHz*
- *UNIFORMLY SMALL SPOT SIZE*
- *DC-COUPLED Z AXIS*
- *ALL SOLID-STATE DESIGN*

The Type 602 Display Unit is a compact, solid-state instrument with excellent resolution providing accurate displays of information from X, Y and Z signal inputs. Application areas are: phase shifts and frequency ratios using *Lissajous* figures, graphic and alphanumeric displays from computers, high-resolution raster displays with intensity modulation and Y-T plots of amplitude versus time displays.

Permanent records of the Type 602 display are provided on Polaroid prints using the Tektronix C-30A Camera with adapt- Two Type 602's may be mounted side-by-side using an onal rack adapter.

VERTICAL AND HORIZONTAL AMPLIFIERS

The X (Horizontal) and Y (Vertical) differential amplifier input circuits are isolated from ground and offer noise-rejection capabilities to minimize noise signals common to the inner and outer conductor of the connecting cables.

BANDWIDTH
DC to 1 MHz at 3-dB down.

DEFLECTION FACTOR
Vertical—90 mV/cm to 135 mV/cm, internally variable.
Horizontal—90 mV/cm to 110 mV/cm, internally variable.

PHASE DIFFERENCE
Not more than 1° between X and Y amplifiers up to 1 MHz.

BEAM POSITION
Front panel vertical and horizontal position ranges permit setting zero signal position to any point on screen. Position shift is not more than 1 mm/h after 20-min warm up.

MAXIMUM INPUT VOLTAGE
±10 V DC plus peak AC.

INPUT RC
100 kΩ ±10% paralleled by 30 pF or less.

RECOMMENDED SOURCE IMPEDANCE
kΩ or less.

CHARACTERISTIC SUMMARY

VERTICAL (Y) AND HORIZONTAL (X)

BANDWIDTH—DC to 1 MHz.

DEFLECTION FACTOR—Vertical 90 mV/cm to 135 mV/cm. Horizontal 90 mV/cm to 110 mV/cm. Internally variable.

PHASE DIFFERENCE—Within 1° between X and Y to 1 MHz.

INPUT R and C—≈100 kΩ and ≈30 pF.

MAXIMUM INPUT VOLTAGE—±10 V DC plus peak AC.

Z AXIS

BANDWIDTH—1 MHz.

SIGNAL AMPLITUDE—0.0 to +1 V.

INPUT R and C—≈100 kΩ and ≈70 pF.

MAXIMUM INPUT VOLTAGE—±10 V DC plus peak AC.

CRT

DISPLAY AREA—8 x 10 cm.

PHOSPHOR—P31.

OTHER

POWER REQUIREMENTS—90 to 136 or 180 to 272 VAC, 48 to 440 Hz. 50 W at 115 VAC, 60 Hz.

Z AXIS

A linear Z-axis amplifier permits intensity modulation of the writing beam. Analog input: DC to 1 MHz over 0.0 V to +1 V range. Signal input is via a BNC connector on the rear panel.

MAXIMUM INPUT VOLTAGE
±10 V DC and peak AC.

INPUT RC
100 kΩ ±10% paralleled by 70 pF or less.

RECOMMENDED SOURCE IMPEDANCE
1 kΩ or less.

5-Inch, 1 MHz Display

602

CRT

TEKTRONIX CRT
5-inch flat-faced rectangular CRT with P31 phosphor standard, P7 phosphor optional.

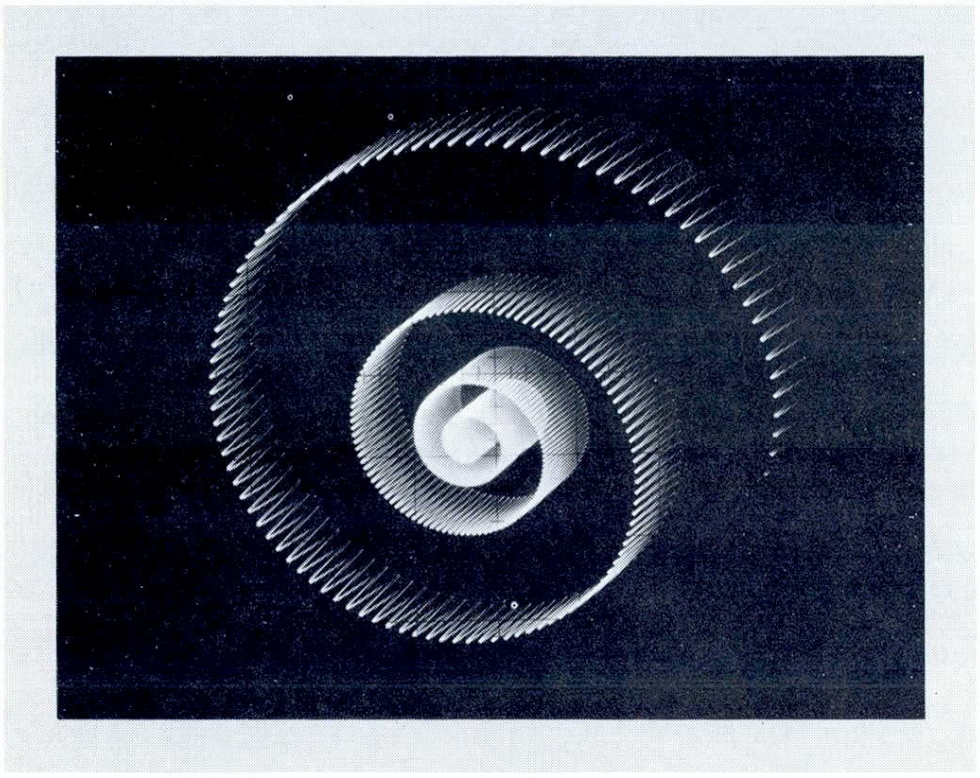
DISPLAY SIZE
8 cm vertically and 10 cm horizontally.

GRATICULE
Standard graticule—internal, parallax-free, variable illumination.

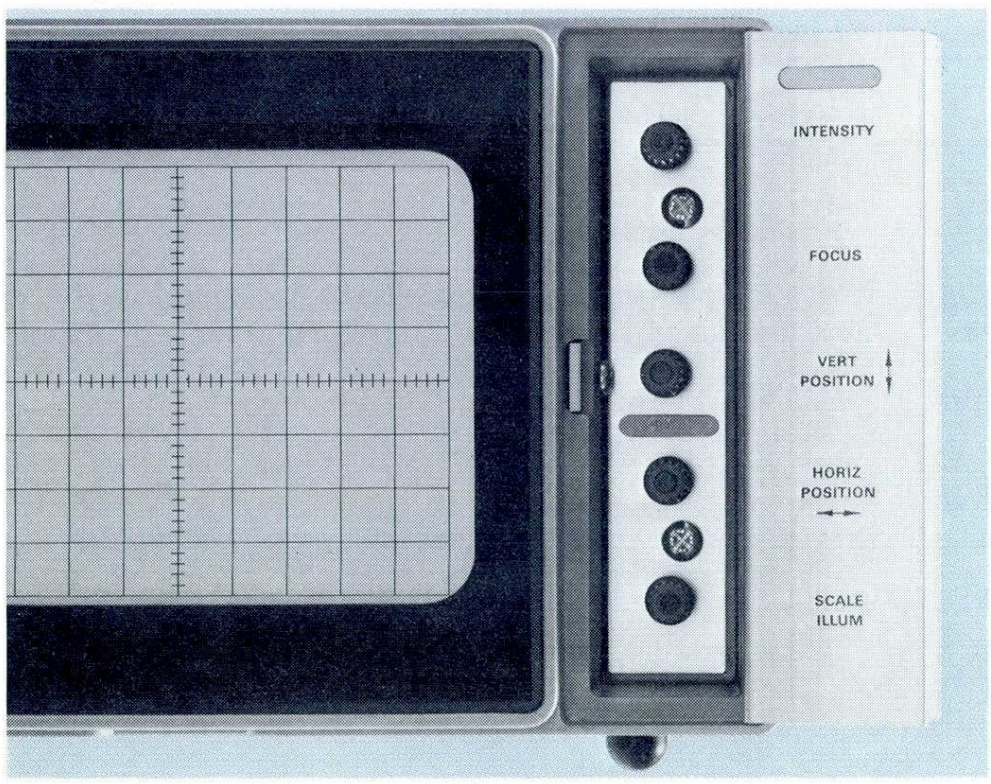
Optional graticule—internal 8 x 10-cm outline (no graticule lines).

TRACE WIDTH
Maximum trace width within the 8 x 10-cm display area is 14 mils at 0.5-μA beam current.

DISPLAY LINEARITY
The difference in any 2-cm deflection on the vertical axis is not more than 1%. The difference in any 2-cm deflection on the horizontal axis is not more than 6%.



Displayed is a low-frequency damped sinewave with 90° phase difference between X and Y inputs. A 1-MHz timing sinewave is also applied to the X, Y and Z input. Intensity modulation with the 1-MHz timing waveform adds the third display parameter and creates the illusion of depth.



Controls are conveniently located behind front panel door.

OTHER CHARACTERISTICS

POWER REQUIREMENTS
90 to 136 VAC or 180 to 272 VAC, 48 to 440 Hz. 50 watts at 115 VAC, 60 Hz. Rear panel selector provides rapid accommodation for six line-voltage ranges.

TEMPERATURE
Electrical specifications are valid over the range of 0°C to +50°C ambient.

FINISH
Blue vinyl painted cabinet, aluminum construction.

DIMENSIONS AND WEIGHTS (cabinet included)

Height	6 in	15.3 cm
Width	8½ in	21.6 cm
Depth	17⅜ in	44.1 cm
Net weight	17½ lb	7.9 kg
Domestic shipping weight	≈22 lb	≈ 9.9 kg
Export-packed weight	≈28 lb	≈12.7 kg

INCLUDED STANDARD ACCESSORIES
Smoke-gray filter, installed (378-0586-00); two instruction manuals (070-0799-00).

TYPE 602 DISPLAY UNIT **$750**

TYPE 602 MOD 174K **$750**
Standard instrument with optional internal 8 x 10-cm outline graticule.

TYPE 602 MOD 146B DISPLAY UNIT **$725**
Standard instrument, without cabinet, for mounting in adapter. Requires 5¼-inch vertical rackmounting space.

If optional P7 phosphor is ordered, smoke-gray filter (378-0586-00) is deleted and orange filter (378-0595-00) is added.

OPTIONAL ACCESSORIES

Optional accessories serve to extend the usefulness of the Type 602 in certain applications.

5¼-INCH RACK ADAPTER FOR TYPE 601, 602, and 528
For mounting two instruments side-by-side in a standard 19-inch rack, order 016-0115-02 ..... $ 95

PANEL ASSEMBLY
For covering ½ of rack adapter when only one Type 602 is rackmounted, order 016-0116-00 ..... $ 8

C-30A CAMERA
f/1.9 lens, magnification variable from 1.5:1 to 0.7:1; Polaroid Land* Pack-Film Back, order C-30A-P $480

Type 602 to C-30A Camera adapter, order 016-0248-00 $ 16

C-30A CAMERA CARRYING CASE
Constructed of heavy-gage, high-impact plastic, has foam-backed, vacuum-formed styrene liner. Holds C-30A Camera, all standard accessories and extra film.

Order 016-0126-00 ..... $ 38

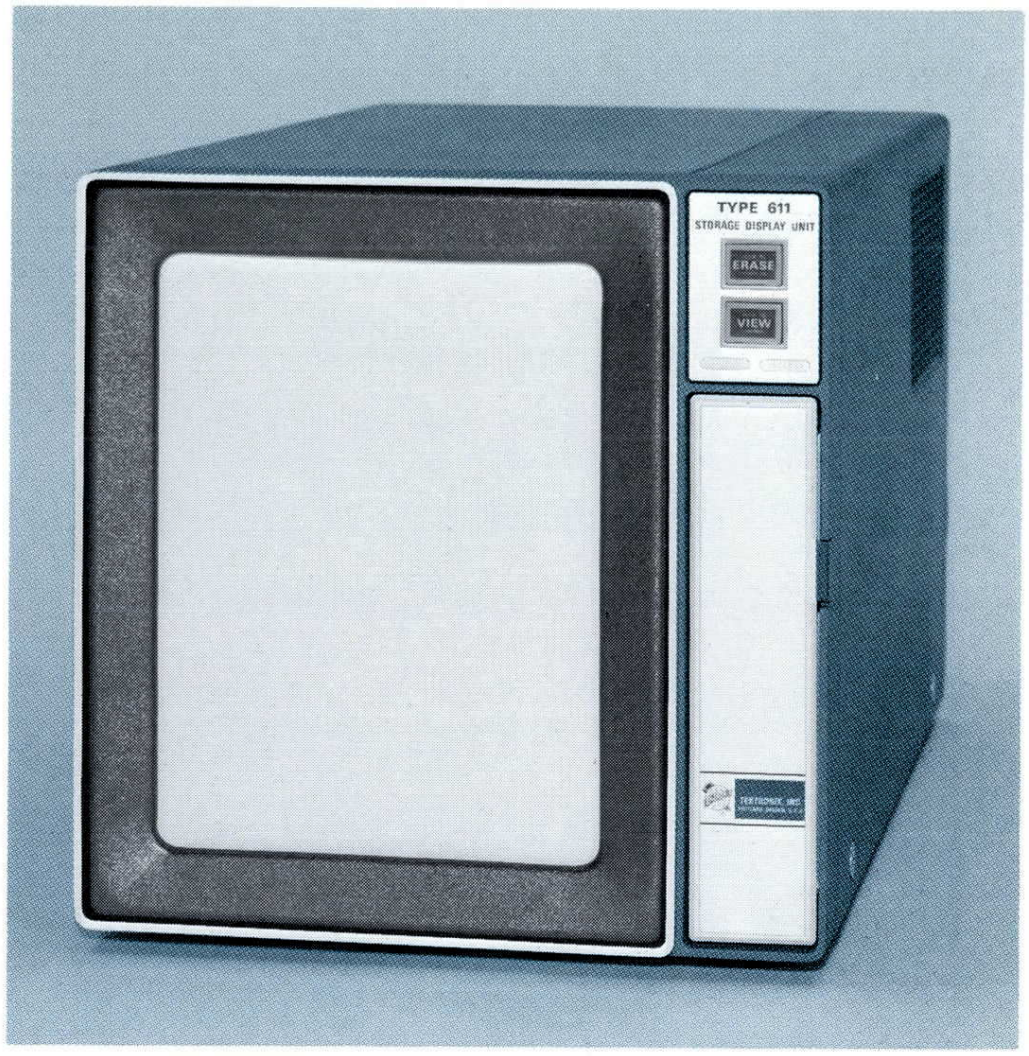
*Registered Trademark, Polaroid Corporation.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

11-Inch Storage Display

611

- ***FLICKER-FREE DISPLAYS***
- ***HIGH RESOLUTION ALPHANUMERIC AND GRAPHICS DISPLAY CAPABILITIES***
- ***WRITE-THROUGH ABILITY***
- ***REMOTE PROGRAMMING OF DISPLAY FUNCTIONS***



The Type 611 Storage Display Unit permits stored displays of combined alphanumeric and graphic information from digital computers and other data transmission systems. The Tektronix-developed bistable Storage CRT used in the Type 611 eliminates the need for costly memory devices for refreshing the information display and provides high information density without flicker or drift and with excellent resolution. A write-through feature provides the operator the ability to visually position the writing beam to any point on the CRT display area without disturbing previously stored information. All solid-state circuit design insures long-term stable performance. The standard instrument provides a vertical format display area with the same aspect ratio as a typewritten page. A horizontal format display is available in a Type 611 Mod 162C.

CHARACTERISTIC SUMMARY

VERTICAL AND HORIZONTAL

CALIBRATED DEFLECTION FACTOR—1-V full screen deflection X and Y axis.

SETTLING TIME—3.5 μs/cm + 5 μs.

Z AXIS

TURN-ON LEVEL—+1 V or greater.

TURN-OFF LEVEL—+0.5 V or less.

INPUT RC—100 kΩ paralleled by 50 pF.

STORAGE CRT

DISPLAY AREA—Vertical—21 cm, Horizontal—16.2 cm. 25% incrementally storable.

RESOLUTION—Equivalent to 400 stored line pairs along the vertical axis; 300 stored line pairs along the horizontal axis.

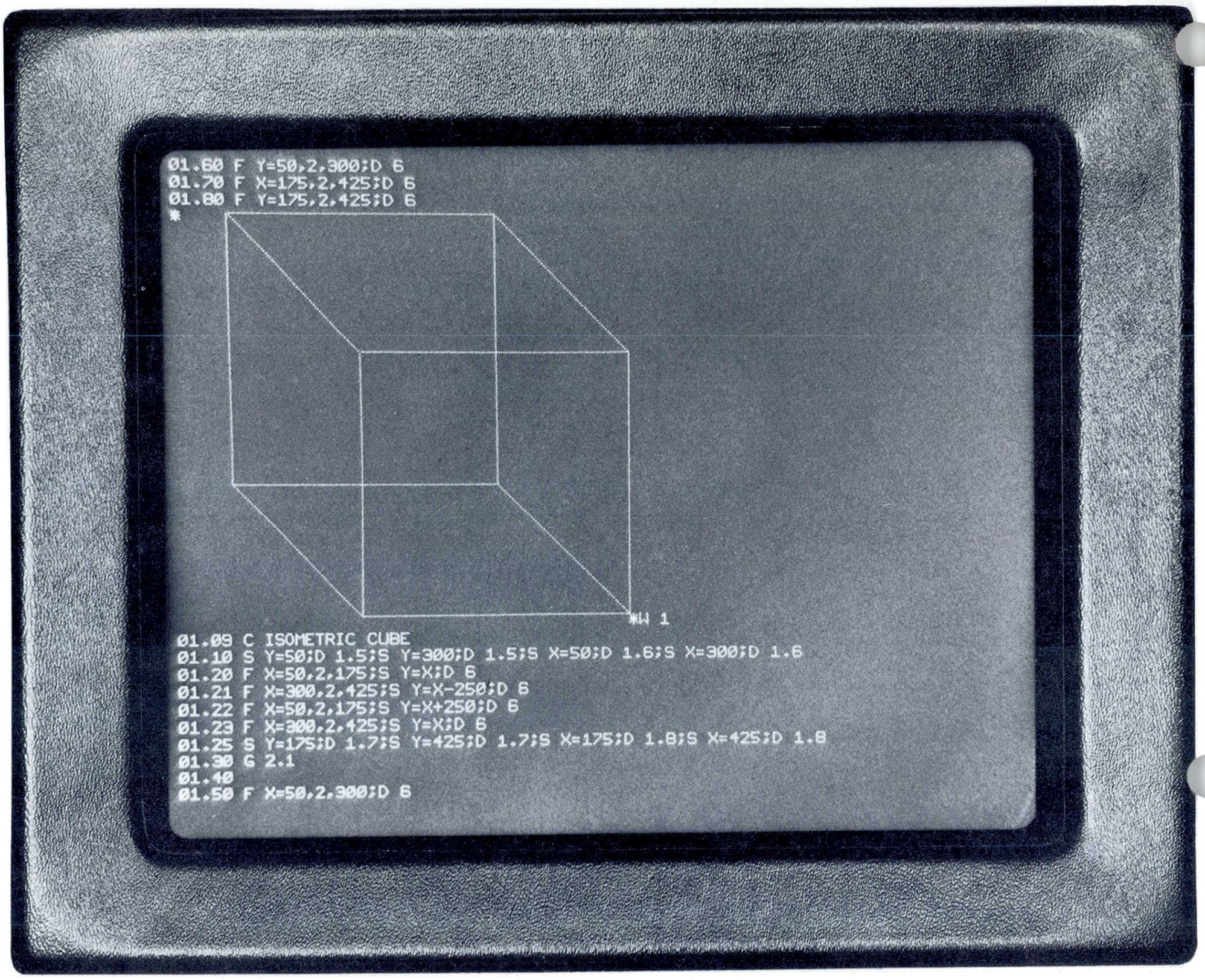
ERASE TIME—0.5 seconds.

DOT WRITING TIME—5 μs.

OTHER

REMOTE CONTROL OF ERASE, NON-STORE, VIEW AND WRITE-THROUGH

POWER REQUIREMENTS—90 to 136 or 180 to 272 VAC, 48 to 66 Hz, 250 watts.



The Type 611 Storage Display Unit is ideally suited for information display applications. Up to 4000 alphanumeric characters may be stored and legibly displayed. The above photo, and the photo on the next page were taken from a Type 611 used as the readout device of a remote computer terminal.

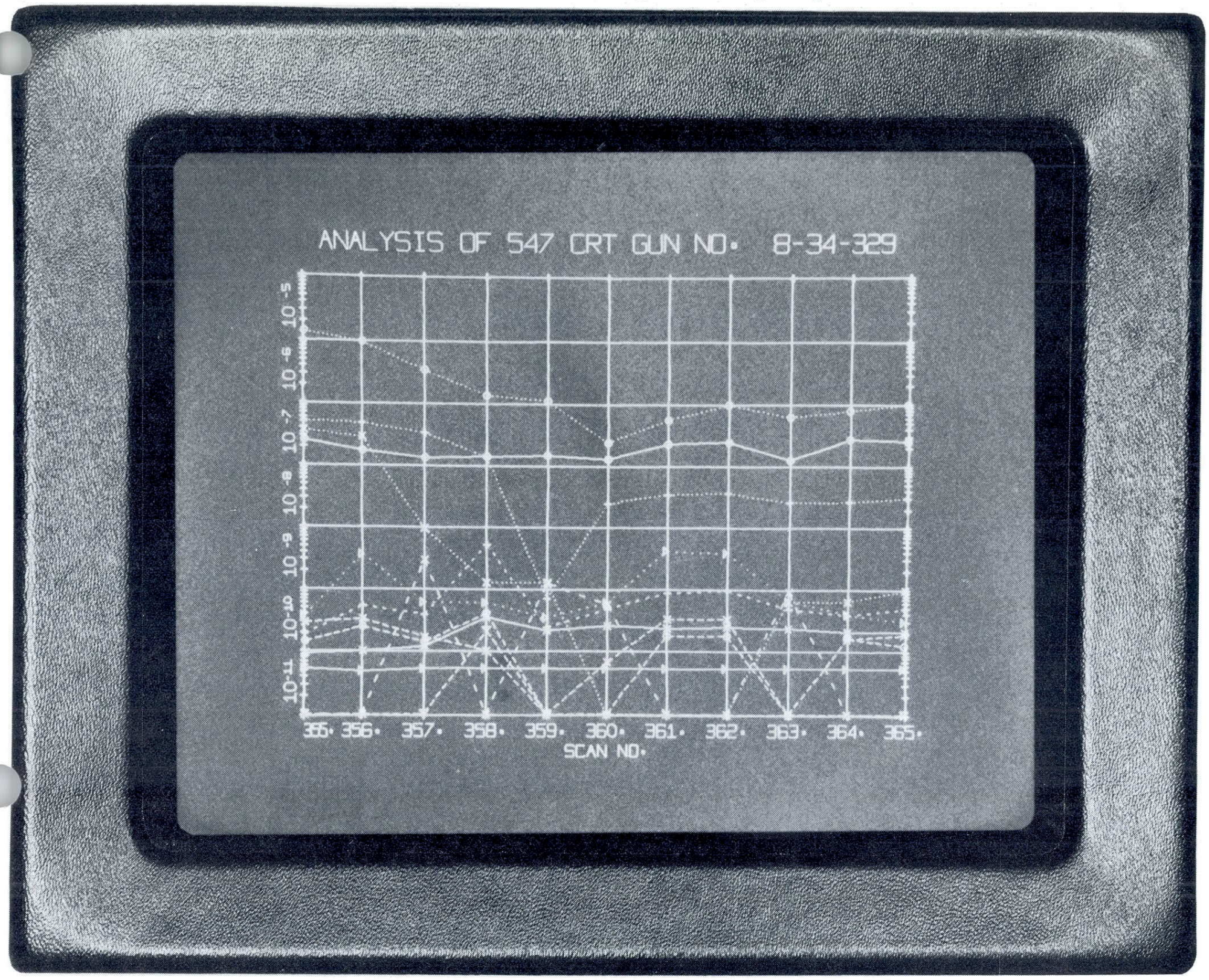
OPERATING FUNCTIONS

The Erase, Non-Store, Write-Through and View operating functions are remotely programmable through contacts at the remote program connector on the rear panel. An Erase Interval signal is also provided at this connector. X, Y, Z inputs are provided through rear BNC connectors or the remote program connector (optional). Manual control of Erase and View is provided on the front panel. Remote programming of the Type 611 is achieved by grounding the appropriate contacts at the rear program connector. The remote switching device must be capable of switching +10 V to approx ground (+0.5 V to —10 V) and handle up to 5 mA of current.

A "ready-to-write" mode is established by erasing the CRT. When the new information has been written, the instrument will be in the "view" mode for approximately one minute and will then automatically switch to the "hold" mode. This holds information stored on the CRT at a low brightness to improve CRT life. Pressing the VIEW switch while in the "hold" mode returns instrument to the "view" mode for approximately 1 minute.

A special "write-through" feature is provided and is programmed through the rear-panel program connector. When the program contact is closed the CRT beam is unblanked if Z axis is activated, and "viewed" without destroying previously stored information, and without storing new information. A combination of reduced beam current and beam movement to form a circular small diameter Lissajous pattern prevents storage.

The Intensity, Focus, Operating Level, Power Switch and Test Spiral controls are located behind a front-panel access door. Pushing the Test Spiral switch causes the instrument to comp[lete] an erase cycle and store a single-shot test pattern presentat[ion]. Pulling TEST SPIRAL switch provides a "non-store" mode with repetitive test pattern for focusing and other tests.



Alphanumeric and graphic display taken from a Type 611 used in a remote computer terminal application.

VERTICAL AND HORIZONTAL AMPLIFIERS

DEFLECTION FACTOR

Vertical—1-V full scale (16.2 cm for square format or 21 cm for rectangular format), accuracy within 2%.

Horizontal—1-V full scale (16.2 cm), accuracy within 2%.

With Attenuation Resistors—Up to 75-V full screen for vertical or horizontal deflection can be obtained by adding attenuation resistors to input circuits.

INITIAL BEAM POSITION

Any one of 9 initial beam positions can be selected by internal switches. Each position is adjustable ±10% of full scale both vertically and horizontally.

SETTLING TIME

μs/cm + 5 μs, to within 1 spot diameter of final position.

POLARITY

Positive input to the vertical and horizontal inputs moves the beam up and to the right.

LINEARITY

The voltage required to produce a 2-cm deflection at any point on the CRT will not vary more than 10%.

MAXIMUM INPUT VOLTAGE

±50 V combined DC and peak AC.

INPUT RC

100 kΩ paralleled by approx 60 pF.

POSITIONAL STABILITY

0.16 mm (or less)/hour with 75-Ω source impedance at 20° C to 30° C. Within 1.6 mm/hour with 75-Ω source impedance at 10° C to 50° C. Reference 25° C.

Z AXIS

INPUT
Turn-on level (unblanked) is +1 V. Turn-off level (blanked) is +0.5 V.

MAXIMUM INPUT VOLTAGE
±50 V combined DC and peak AC.

INPUT RC
100 kΩ paralleled by approx 50 pF.

Rear panel of Type 611 Storage Display Unit.

CRT DISPLAY AND STORAGE

TEKTRONIX CRT
11-inch flat-faced bistable storage tube, phosphor similar to P1.

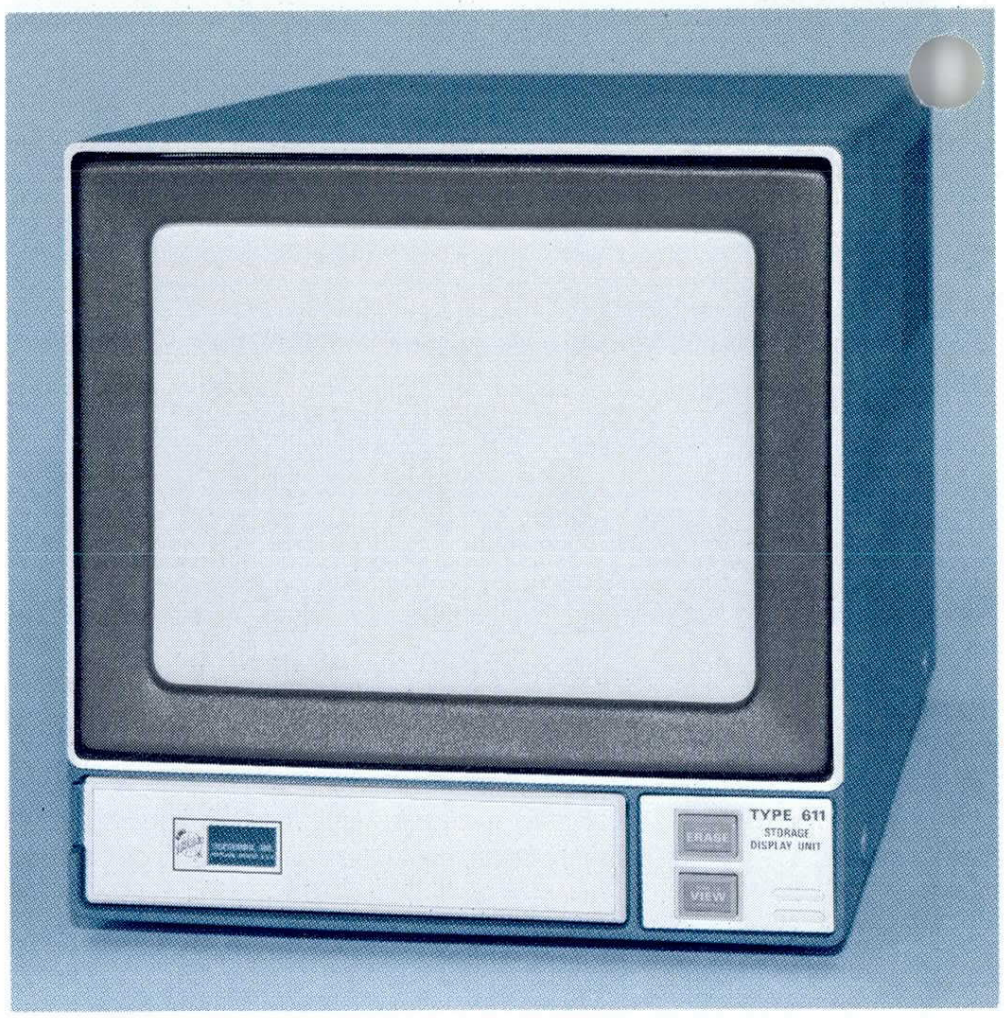
DISPLAY SIZE
Vertically—21 cm (approx $8\frac{5}{32}$ in), Horizontally—16.2 cm (approx $6\frac{7}{16}$ in). Display area is up to 25% incrementally storable.

STORED LUMINANCE
At least 6 foot-lamberts.

CONTRAST RATIO
6:1 or greater.

RESOLUTION
4,000 characters based on a 90 x 70 mil matrix, clearly legible with good spacing. Equivalent to 400 vertical x 300 horizontal stored line pairs. (Resolution is measured using 400 x 300 stored dots since closely spaced line pairs exceed 25% incremental storage.)

VIEWING TIME
Less than 15 min recommended. Viewing time may be extended to one hour; however, erasure of previously stored information becomes more difficult.



Type 611 MOD 162C features a horizontal display format.

ERASE TIME
500 ms or less.

DOT WRITING TIME
5 μs is required to write (store) one bit of information.

OTHER CHARACTERISTICS

ERASE INTERVAL PULSE
A negative-going erase pulse is provided at the rear program connector to inhibit external equipment during an erase cycle. Amplitude is approx 10 V, source impedance approx 2 kΩ.

POWER REQUIREMENTS
90 to 136 VAC or 180 to 272 VAC, 48 to 66 Hz, 250 watts maximum at 115 V and 60 Hz. Rear panel selection provides rapid accommodation for six line-voltage ranges.

DIMENSIONS AND WEIGHTS

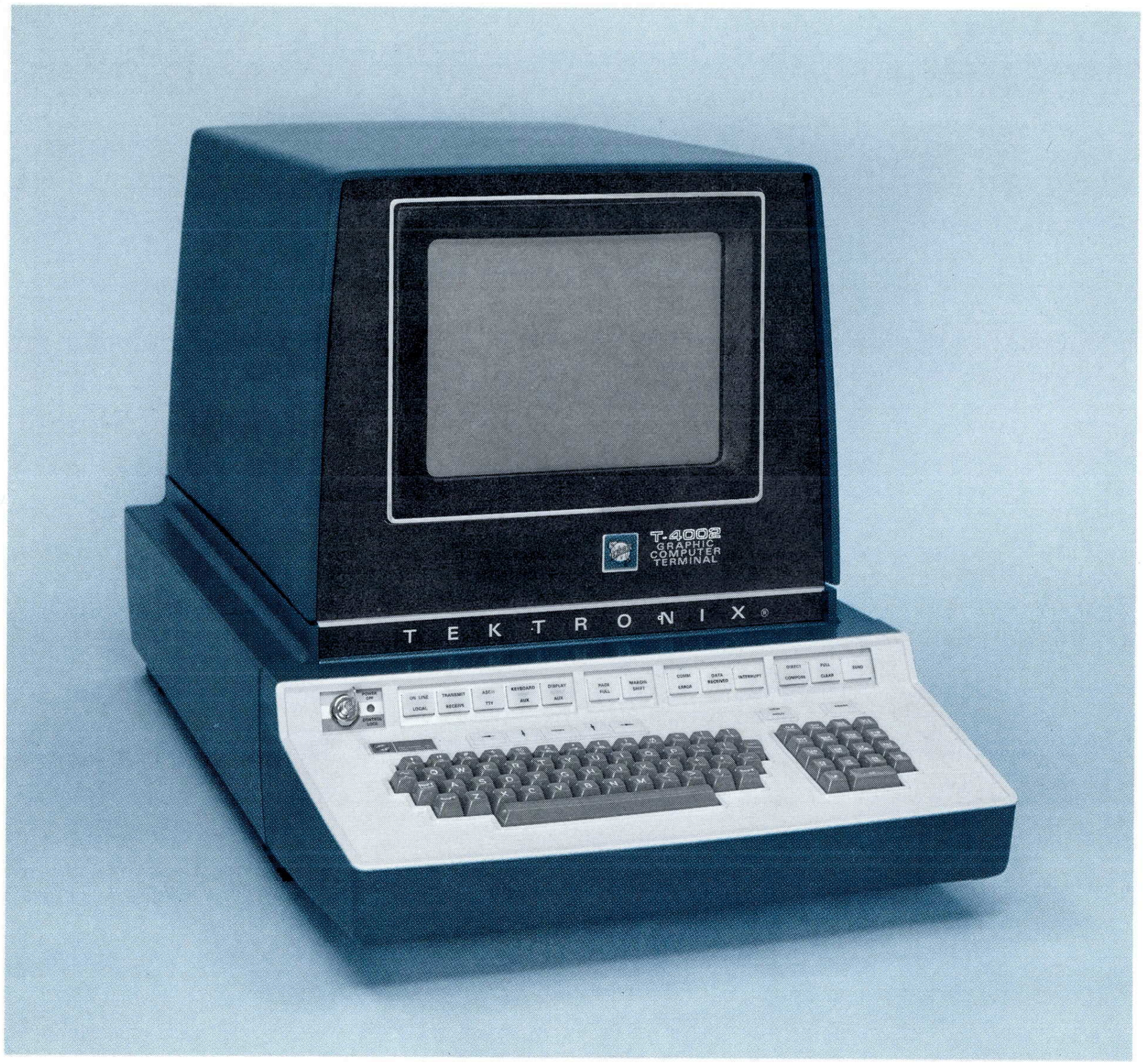
Height	$11\frac{7}{8}$ in	30.1 cm
Width	$11\frac{5}{8}$ in	29.5 cm
Depth	$22\frac{3}{8}$ in	56.8 cm
Net weight	51 lb	23.1 kg
Domestic shipping weight	≈62 lb	≈28.1 kg
Export-packed weight	≈72 lb	≈32.6 kg

INCLUDED STANDARD ACCESSORIES
External program connector (131-0570-00); connector cover (200-0821-00); 3 to 2-wire adapter (103-0013-00); two instruction manuals (070-0752-00).

TYPE 611 STORAGE DISPLAY UNIT **$2695**

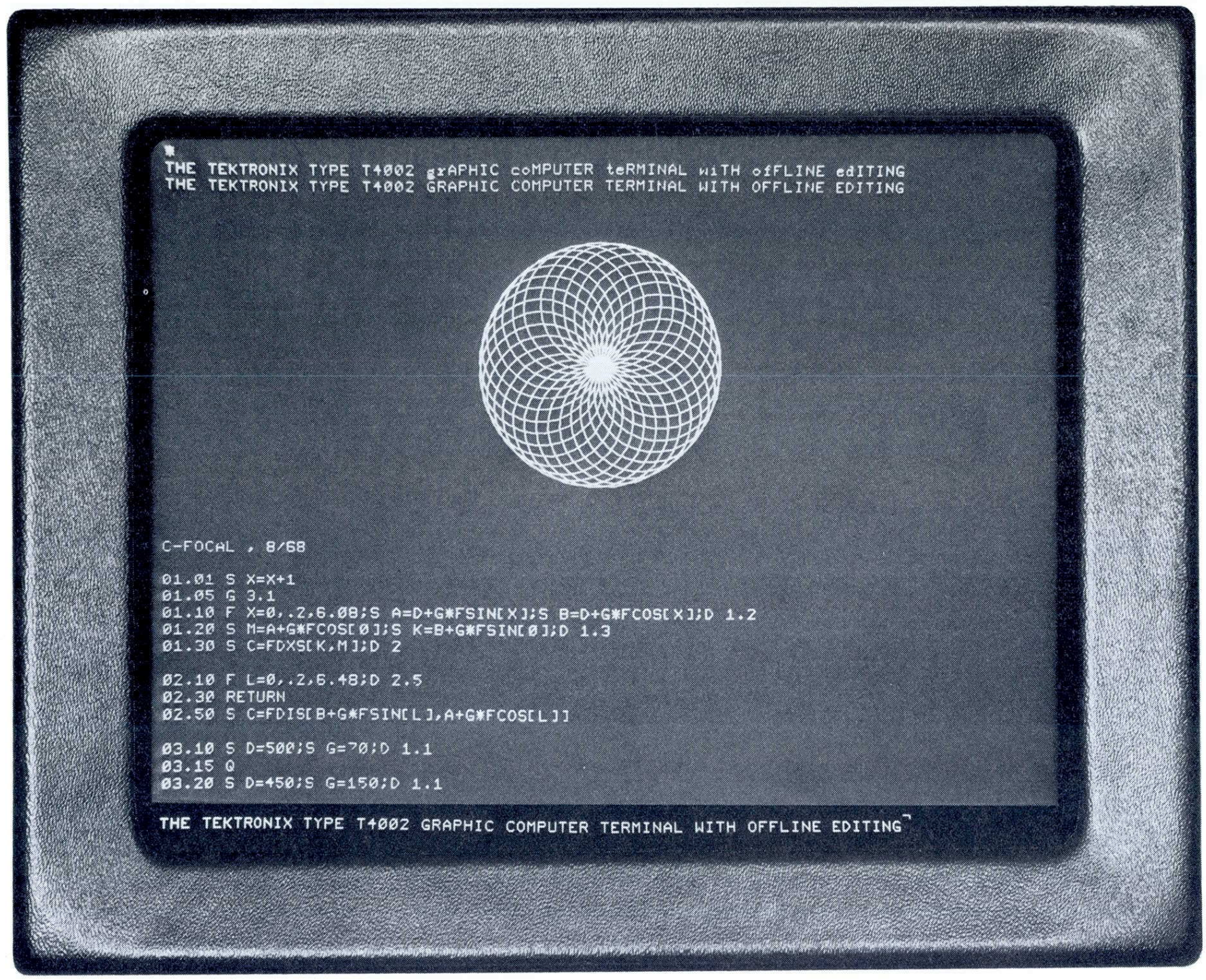
TYPE 611 MOD 162C **$2695**
Horizontal display format with same accessories as standard instrument.

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.



- ***COMPLEX GRAPHICS***
- ***HIGH-DENSITY ALPHANUMERICS***
- ***FLICKER-FREE STORED DISPLAYS***
- ***LINE-BUFFER AREA FOR EDITING***
- ***SOLID-STATE DESIGN***

The Tektronix Type T4002 Graphic Computer Terminal is a completely self-contained, desk-top, information display system designed to facilitate rapid and efficient exchange of information between man and computer. Complete communication interaction is achieved through a solid-state, data-entry keyboard and visual displays of high-resolution alphanumerics and graphics. A Tektronix developed, direct-view storage cathode-ray tube is used as the display medium. High-density alphanumerics and complex graphics are presented without flicker or drift. Resolution achieved is equivalent to 400 x 287 line pairs.



The Line-Buffer feature of the T4002 simplifies text composition, verification and correction. The first line in the above photograph is incorrect. The line is recalled from the buffer memory and corrected in the Line-Buffer area at the bottom of the display. After correction, the line is retransmitted to the stored display area.

CHARACTERISTIC SUMMARY

CONTROL PANEL

KEYBOARD—Full USASCII (128 codes).
POWER—Key switch.
CONTROL LOCK—Key switch for security purposes.
MODE CONTROLS AND INDICATORS:
- **ON LINE/LOCAL**
- **TRANSMIT/RECEIVE**—Communication-mode status.
- **ASCII/TTY**—Communication-code indicator.
- **DISPLAY/AUXILIARY** or both—Input source indicator.

SPECIAL FUNCTIONS:
- **PAGE FULL**—Halts output when screen is full.
- **MARGIN SHIFT**—Allows four fixed margin positions for increased information.
- **COMM ERROR** —Lights on detected error.
- **DATA RECEIVED**—Indicates computer output.
- **INTERRUPT**—Used to halt computer output.

DISPLAY CHARACTERISTICS

DISPLAY AREA—15.2 cm x 21 cm.
ERASE TIME—0.5 second.
LUMINANCE— >6 fL.
CONTRAST RATIO— >6:1.
RESOLUTION—Equivalent to 400 x 287 line pairs.

DISPLAY CAPABILITY

96 USASCII symbols including both upper and lower case characters, numbers and special symbols.

GRAPHICS:
- Point plot.
- Incremental plot.
- Linear interpolation (vector).
- 1024 x 1024 addressable points.
- 1024 (X) by 742 (Y) viewable points.

ALPHANUMERIC:
- 39 lines, 85 characters per line in stored area.
- 1 line, 84 characters in Line-Buffer area.
- 2 sizes of characters under program control.
- 2000 characters per second (average) writing capability.

INTERFACE UNITS

TYPE 4801—For Digital Equipment Corporation PDP-8 Series Computers with negative input/output buses.
TYPE 4802—For use with devices which transfer data serially in either full or half-duplex mode. Conforms to EIA Standard RS-232B (October, 1968).
TYPE 4803—For Digital Equipment Corporation PDP-8 Series Computers with positive input/output buses.

Graphic Computer Terminal

T4002

CONFIGURATION

All of the elements required to effectively communicate with a computer are contained within the T4002 console. System components are: display unit; terminal control; character generator, input/output interface; and keyboard. Space is provided within the terminal to accommodate an auxiliary module for expanding system capability. Interfaces are available for direct coupling to computers or data communication systems.

DISPLAY UNIT

A Tektronix, 11-inch, direct-view, bistable storage tube is used as the display medium. High-density alphanumerics and complex graphics are presented without flicker or drift. The 15.2-cm by 21-cm screen will accommodate up to 39 lines of alphanumeric characters with 85 symbols per line. More than 3000 characters may be displayed with excellent clarity. Resolution achieved is equivalent to 400 x 287 line pairs. The luminance level of stored information is at least 6 fL and contrast ratio at least 6:1.

LINE-BUFFER AREA

The Line Buffer capability of the T4002 makes use of one 84-character line of discrete memory. Data is entered through the keyboard, stored in memory, and displayed in a 1-cm x 21-cm continuously refreshed, flicker-free area at the bottom of the screen. The information in this memory can be verified and edited before it is sent to the computer as a single message block.

A cursor is always positioned over the next area to be written. Any character may be changed by backspacing the cursor to the character to be changed. Backspacing past a character erases that character from local memory. Pressing the SEND control transmits the Line Buffer Area information to the computer if ON LINE, or to the designated output device if in LOCAL.

KEYBOARD

Manual entry of data is through a solid-state keyboard with full USASCII capability (128 codes). 96 upper and lower-case characters, numbers and special symbols are provided for alphanumeric data entry. Two sizes of characters are under program control. 32 additional control characters are included for communications between the computer and the terminal.

TERMINAL CONTROL

The terminal control provides timing logic, data buffers and interconnection logic for the character generator, keyboard and auxiliary module. Linear interpolation is a function of the terminal control, D/A converters and plot logic. 1024 by 1024 points are addressable. 1024 (X) by 742 (Y) points are viewable.

CHARACTER GENERATOR

The character generator provides a set of 96 USASCII characters, including 1 "space" and 1 "delete" character. Two sizes of characters are under program control, 70 x 90 mils and 140 x 180 mils. Up to 2000 characters per second (average) may be generated and stored on the display tube.

CONTROLS AND INDICATORS

In addition to a standard alphanumeric keyboard, other controls are provided to enhance ease of operation. The number of panel controls are minimized and control functions made automatic where practical (see photo of control panel).

1. **CONTROL CHARACTERS**—The USASCII provides for 32 control characters to be utilized for communication between computers and remote I/O equipment. Keys to activate these control characters are provided on the right portion of the keyboard. Functions peculiar to the Type T4002 are also controlled from this keyboard area.
2. **VIEW/HOLD**—Switches the display from a hold mode to a view mode for 1 to 2 minutes.
3. **ERASE**—The erase function erases the entire stored display area.
4. **FORMAT CONTROLS**—Provide a means of moving the cursor when fixed-format alphanumerics are used. The five format buttons (top left of keyboard) move the cursor UP, DOWN, RIGHT, LEFT or HOME (fixed point upper left corner—resets T4002 from Graphics to Alphanumerics).
5. **POWER OFF/ON/CONTROL LOCK**—Key-operated, 3-position rotary switch controls line voltage to the T4002. A color-coded mechanical flag showing through the POWER ON aperture indicates the position of the switch. CONTROL LOCK is a "security" position in which input from the T4002's control panel and keyboard is locked out.

6. **ON LINE/LOCAL**—Controls on-line and off-line terminal operation and indicates status.
7. **TRANSMIT/RECEIVE**—Controls and indicates the communication mode status.
8. **ASCII/TTY**—Indicates and controls communication code being output by the keyboard.
9. **INPUT: KEYBOARD/AUX**—Permits selection of KEYBOARD or AUXILIARY as input to computer. Indicates status.
10. **OUTPUT: DISPLAY/AUX**—Permits selection of the DISPLAY or AUXILIARY or both to receive output from computer. Indicates status.
11. **PAGE FULL**—Indicates full page and stops information from computer (in alphanumeric mode only).
12. **MARGIN SHIFT**—Allows a choice of four fixed margin positions, starting on the left and moving to the right. Useful when writing columns of short statements.
13. **COMM/ERROR**—Indicates an error at the terminal control interface.
14. **DATA RECEIVED**—When the computer makes an entry to the display, the indicator lights. Pressing the control extinguishes the indicator.
15. **INTERRUPT**—Any time the computer is sending data all controls on the terminal are inhibited except the INTERRUPT switch (and the POWER switch). Pressing this switch stops the transmission and allows the operator to send data to the computer.
16. **DIRECT/COMPOSE**—Controls text editing function and indicates status.
    Direct: Each character is processed as it is typed.
    Compose: Each character is sent to an editor-buffer for future corrections, additions, or processing.
17. **FULL/CLEAR**—Overflow indicator lights when the editor-buffer capacity is reached. Depressing the control will clear the editor-buffer of stored information.
18. **SEND**—Pressing the control causes the information in the editor-buffer to be transmitted to the computer if in ON LINE and to the designated output device if in LOCAL.

OTHER CHARACTERISTICS

POWER REQUIREMENTS

A quick-change line-voltage selector provides six ranges: 90 to 110 V, 104 to 126 V, 112 to 136 V, 180 to 220 V, 208 to 252 V, and 224 to 272 V. Frequency range is 48 to 66 Hz. Maximum consumption at 115 V is 400 watts.

OPERATING TEMPERATURE

Normal operation over 20° C to 40° C range.

DIMENSIONS AND WEIGHTS

Height	19⅜ inches	48.7 cm
Depth	34⅞ inches	88.7 cm
Width	19 inches	48.3 cm
Net weight	130 pounds	46.8 kg

TYPE T4002 GRAPHIC COMPUTER TERMINAL $8800

OPTIONS

INTERFACE UNITS

The interface provides code conversion, logic level and necessary connections to interface the terminal with certain computers and data communication systems. Currently, three types of interface are available: Type 4801 for Digital Equipment Corporation PDP-8 Series Computers with negative input/output buses. Type 4802* designed to communicate with devices which transfer data serially in either full or half-duplex mode. (Conforms to EIA Standard RS-232-B, October, 1968.) Type 4803 for Digital Equipment Corporation PDP-8 Series of computers with positive input/output buses.

*NOTE: Timing Interface Boards are factory wired for a specified baud send and receive rate. Since the Type 4802 has a multitude of send and receive capabilities, the customer must advise a baud rate for both send and receive before his Type 4802 order is complete. Additional boards may be ordered. Each board would be factory wired to the customer's baud rate specifications.

TYPE 4801 COMMUNICATION INTERFACE, WITH CABLE $675
(Includes instruction manual 070-0997-00).

TYPE 4802 DATA COMMUNICATION INTERFACE, WITH CABLE $600
(Includes instruction manual 070-0998-00).

TYPE 4803 DATA COMMUNICATION INTERFACE, WITH CABLE . . . . . $[illegible]5
(Includes instruction manual 070-1041-00).

Additional Timing Interface Boards are available to facilitate operation at baud rates other than that specified on Type 4802 order. Specify Transmit and Receive baud rates necessary with each order for additional boards.

ORDER TIMING INTERFACE BOARD $125

AUXILIARY INTERFACE

Space is provided inside the terminal for a plug-in module to expand future capability. The module may be used for a customer designed interface unit to integrate input/output equipment, such as tape or disk drives, printers, mechanical plotters, card readers/punches, etc., into the system, or for some other purpose. A blank plug-in is available from Tektronix for use as a frame in which to build the auxiliary module.

BLANK PLUG-IN MODULE, order 040-0507-00 . . . . $83

CAMERA

The C-10 is a fixed-focus, light-weight camera designed for use with the Type T4002. An f/8 lens with sufficient depth of field and convenient hand grips allow the C-10 to be held against the display area for photographing of displays. The C-10 housing accommodates a Graflok[1] 4 x 5 back.

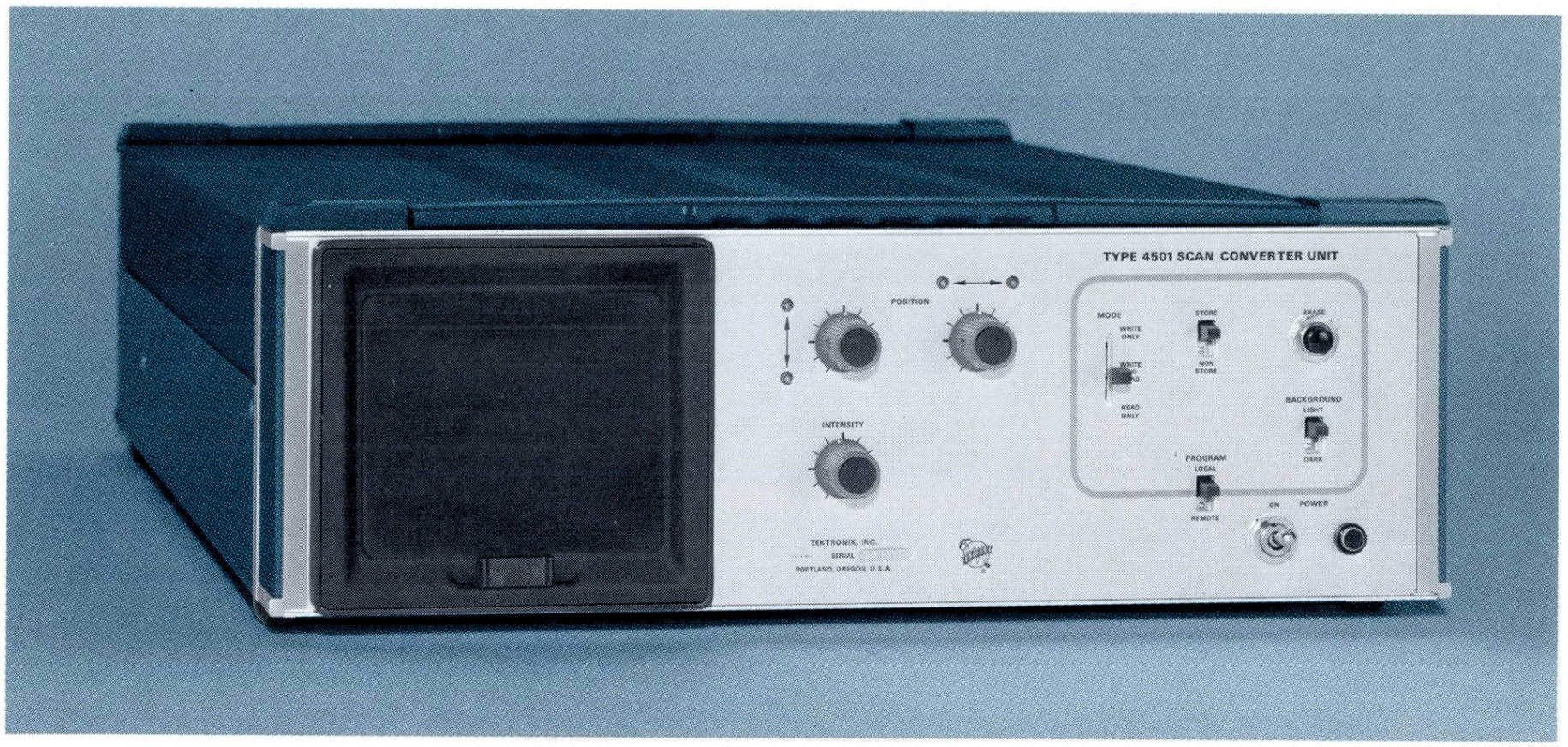
C-10 CAMERA $400

[1]Registered Trademark Graflex, Inc.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

NOTE: SEE PAGES 270-272 FOR ADDITIONAL INFORMATION ON THE T4002.

4501 Scan Converter R4501

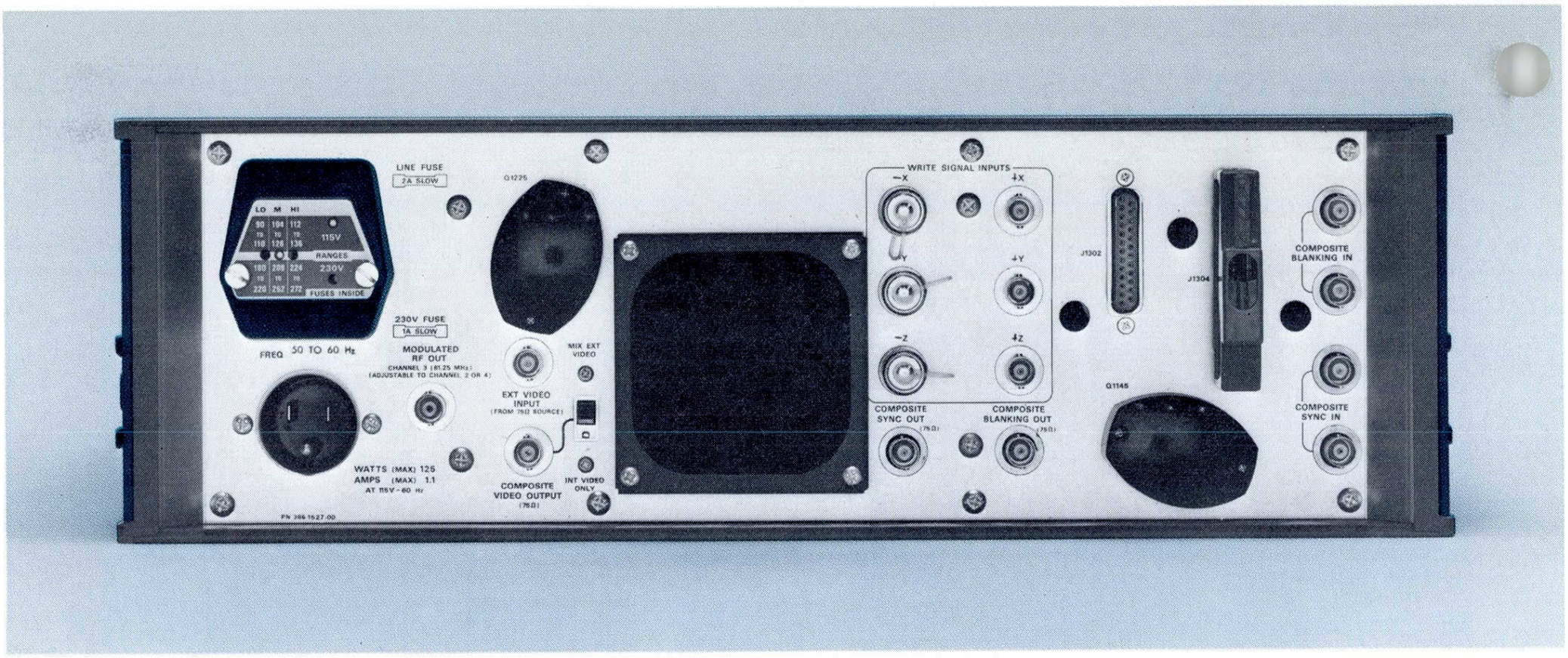


- ***Conventional or stored displays are converted to composite video and modulated RF for viewing on bright, large-screen, TV monitors or receivers.***
- ***Video output conforms to EIA, 525-line/60-field or CCIR, 625-line/50-field television standards.***
- ***Storage capability permits convenient viewing of single-event or low-repetition rate information.***
- ***Output from a single scan converter may be looped through a multiple number of monitors for viewing at remote locations.***
- ***Wideband X and Y amplifiers, DC-to-10 MHz frequency response.***
- ***Remotely programmable.***

The Type 4501 Scan Converter Unit is an analog memory device with readout in the form of a composite television signal. Information written on its 5-inch storage tube is converted to composite video or modulated RF for convenient viewing on large-screen television monitors or receivers. The bright displays achieved in this manner are ideal for individual or group viewing under high-ambient light conditions. A Tektronix, 5-inch rectangular bistable storage tube is utilized as the memory device and provides resolution equivalent to 100 by 125 stored line pairs.

The output video signal conforms to EIA 525-line, 60-field television standards. Provision is made to internally switch to CCIR, 625 line, 50 field to accommodate European television standards. The modulated RF output permits displaying information on Channel 2, 3, or 4 of conventional television receivers.

4501 Scan Converter R4501



DISPLAY MODES

The scan converter may be operated in a STORE or NON-STORE mode. In the STORE mode, information from X, Y and Z-axis signal inputs is stored in a conventional manner on the storage CRT. Conversion is obtained by raster scanning the storage target with the CRT writing beam. The detected signal is then combined with internally generated television sync and blanking, and is provided at the rear panel as composite video or modulated RF. Operation of the Type 4501 in the NON-STORE mode is similar to operating in the STORE mode except displays are not retained. In this mode dynamic displays of changing information may be scan converted for large-screen viewing.

Associated with the STORE and NON-STORE operating modes are the WRITE ONLY, WRITE AND READ and READ ONLY operating functions. The WRITE AND READ function permits a display to be visually written and read simultaneously. This is accomplished by "time-sharing" the single electron beam. Using the same deflection amplifiers and electron beam to perform the write and read functions insures excellent input-output tracking, thus adding negligible position errors to the output monitor.

VERTICAL AND HORIZONTAL AMPLIFIERS

The DC coupled X (horizontal) and Y (vertical) differential input amplifiers provide cancellation of common-mode signal components, permit convenient polarity inversion and provide a means for mixing of two signals from separate sources. The display aspect ratio is 3 units vertical and 4 units horizontal. Access to (+) and (—) inputs is through rear-panel BNC connectors. Simultaneous access to the (+) inputs is available through the remote program connector.

DEFLECTION FACTOR

Vertical— 0.75-V full screen (7.5 cm), variable from 0.375-V full screen to 1.125-V full screen with internal adjustment.

Horizontal— 1.0-V full screen (10 cm), variable from 0.5-V full screen to 1.5-V full screen with internal adjustment.

POLARITY SENSE—(+) X input moves the beam up, (—) X input moves the beam down, (+) Y input moves the beam right, (—) Y input moves the beam left.

MAXIMUM INPUT VOLTAGE—200 V, (DC plus peak AC).

INPUT RC—1 MΩ within 2%, paralleled by 47 pF.

POSITION STABILITY—Within 10 mV of graticule c[illegible], +20° C to +30° C; within 50 mV of graticule center, 0° C to +50° C.

GAIN STABILITY—Within 1% of setting, +20° C to +30° C; within 4%, 0° to +50° C.

DOT SETTLING TIME—0.15 μs or less to within 1% of final position.

BANDWIDTH—(X and Y amplifiers) at least 10 MHz within center 7.5-cm scan area, +20° C to +30° C.

PHASE DIFFERENCE—Within 10° between X and Y at 10 MHz.

DIFFERENTIAL INPUT

LINEAR COMMON MODE SIGNAL RANGE—+ and — 2.5 V, total not to exceed 5 V P-P.

COMMON MODE REJECTION RATIO—≥500:1 at 10 kHz; ≥100:1 at 1 MHz; ≥10:1 at 10 MHz.

Z AMPLIFIER

The DC-coupled Z-axis amplifier provides cancellation of common-mode signal components, permits convenient polarity inversion and provides a means for mixing of two signals from separate sources. In all WRITE modes, the CRT beam intensity is determined by the Z-axis input and the INTENSITY control. Access to (+) and (—) inputs is through BNC connectors on the rear panel. Simultaneous access to the (+) input is available through the remote program connector.

The Z amplifier input has two operating modes: LINEAR [illegible]d LIMITING.

4501 Scan Converter R4501

The information written on the 5-inch CRT of the scan converter (bottom) is converted to composite video and is displayed on the 17-inch CONRAC monitor (top).

LINEAR AMPLIFIER CHARACTERISTICS (Single ended or differential input)

POLARITY SENSE—Positive signal on the (+) input increases intensity, negative signal on the (—) input increases intensity. (Intensity modulation of the CRT beam is the resultant difference between the signal applied to the (+) and (—) Z-axis inputs).

LINEAR COMMON MODE SIGNAL RANGE— + and — 2.5 V, not to exceed 5 V P-P.

MAXIMUM INPUT VOLTAGE—200 V (DC plus peak AC).

COMMON MODE REJECTION RATIO— $\geq$500:1 at 10 kHz; $\geq$100:1 at 1 MHz; $\geq$10:1 at 10 MHz. (A single-ended signal to either (+) or (—) input receives rejection of common-mode components existing on the signal lead and the signal ground.)

INPUT RC—1 MΩ, ±2% paralleled by 47 pF.

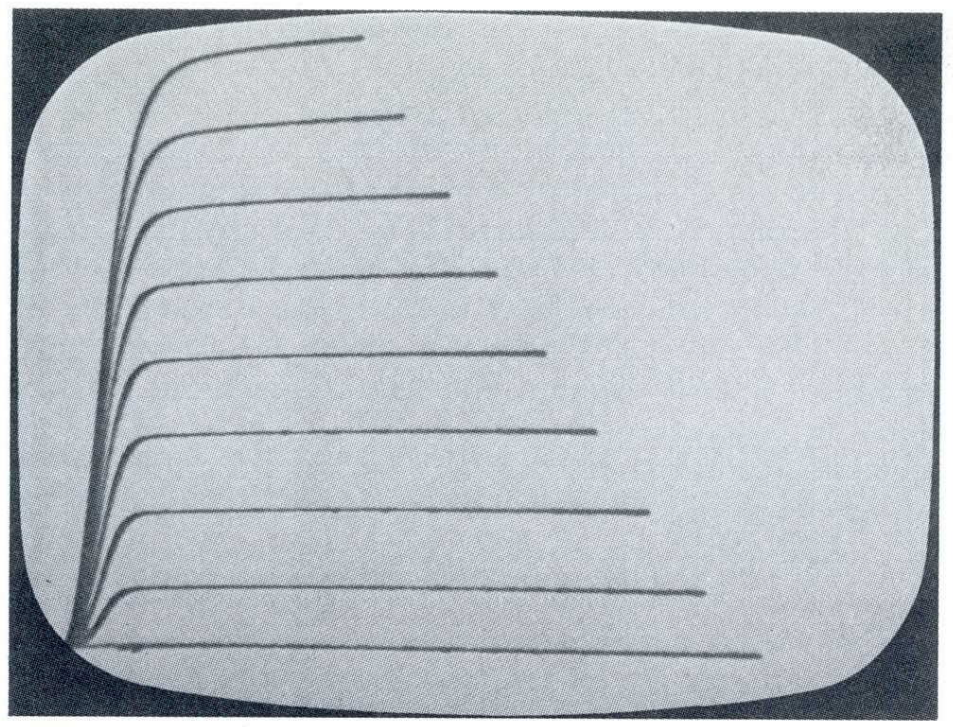
AMPLITUDE REQUIREMENTS—Maximum intensity is achieved at 1.0 V P-P. Normal writing intensity is produced by 0.5 V P-P and minimum useable intensity is 0.05 V P-P.

BANDWIDTH— $\geq$5 MHz with 1-V input.

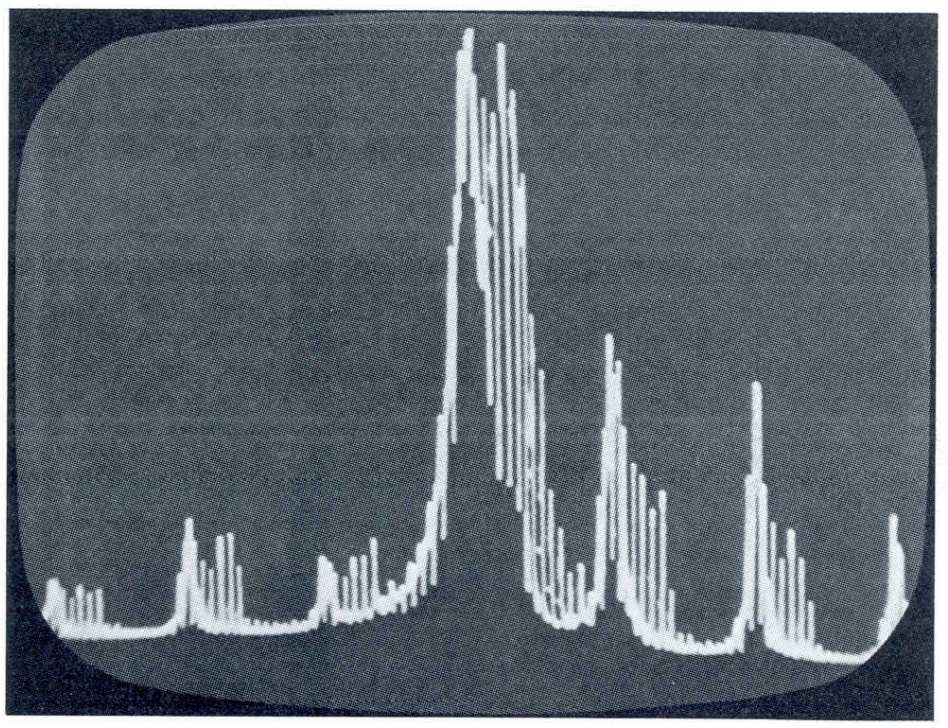
RISETIME—$\leq$75 ns with 1-V input step.

LIMITING AMPLIFIER CHARACTERISTICS

A single-ended signal at the (+) input connector can be routed through an amplitude limiting stage by moving an internal switch. The drive signal to the Z-axis amplifier is automatically limited to 1 V P-P.



Displays may be viewed with a light or dark background (top and bottom photo). The front-panel BACKGROUND switch provides a choice of LIGHT (written area is displayed dark on a light background) or DARK (written area is displayed light on a dark background).



INPUT REQUIREMENTS—Voltage levels of +1 V or more turn the beam on to a fixed level. The fixed level can be adjusted with the intensity control. Voltage levels of +0.5 V or less keep the beam turned off.

MAXIMUM INPUT VOLTAGE—50 V (DC and peak AC).

CRT

TEKTRONIX CRT—5-inch, flat-faced bistable storage tube, phosphor similar to P1.

STORED RESOLUTION—Equivalent to 100 line pairs along the vertical axis. Equivalent to 125 line pairs along the horizontal axis.

ASPECT RATIO—Three units vertically by four units horizontally.

4501 Scan Converter R4501

STORAGE TIME—15 minutes or less.

DOT WRITING TIME—8 μs or less.

READ RASTER

Readout is accomplished by scanning the CRT storage target with a TV raster. The necessary TV sync, blanking and raster scanning voltages are developed in the scan converter unit. Sync and video are combined to assemble a composite TV signal. An internal switch permits selection of either EIA 525-line, 60-field or CCIR 625-line, 50-field TV standards. Provision is made to automatically utilize external sync and blanking when these signals are connected to the scan converter.

SYNC FREQUENCY

	EIA	CCIR
Vertical	60 Hz or $\frac{1}{525}$ H	50 Hz or $\frac{1}{625}$ H
Horizontal	15.75 kHz within 0.012%	15.625 kHz within 0.012%

COMPOSITE SYNC AND BLANKING OUTPUTS

Conforms to EIA or CCIR timing requirements. Amplitude is —4 volts within 0.2 V into 75 Ω.

COMPOSITE SYNC AND BLANKING INPUTS

Inputs must meet EIA or CCIR timing requirements. 75-Ω loop through connections allow one or more units to be driven by the same source. Return loss is ≥30 dB, 50 Hz to 5 MHz.

READOUT

VIDEO OUTPUT

Video polarity is black negative. Output amplitude is 30 to 150 mV above blanking level for stored signals and 600 to 800 mV above blanking level for un-stored signals if a light background large display is being used. The inverse is true if a dark background display is used.

MODULATED RF OUTPUT

The carrier frequency is set to 61.25 MHz (TV Channel 3) and is internally adjustable from 55.25 MHz (TV Channel 2) to 67.25 MHz (TV Channel 4). Frequency stability is within 250 kHz of carrier frequency from 20° C to 30° C. Amplitude is at least 10 mV P-P into 75 Ω.

REMOTE PROGRAMMING

Remote programming of the Type 4501 Scan Converter Unit is accomplished through 2 rear-panel program connectors. The NON-STORE, ERASE, READ ONLY, WRITE ONLY and BACKGROUND are externally programmable by grounding or switching between +0.5 V and —10 V on the appropriate program line. The (+) inputs to the X, Y and Z amplifiers are also available at the remote program connectors.

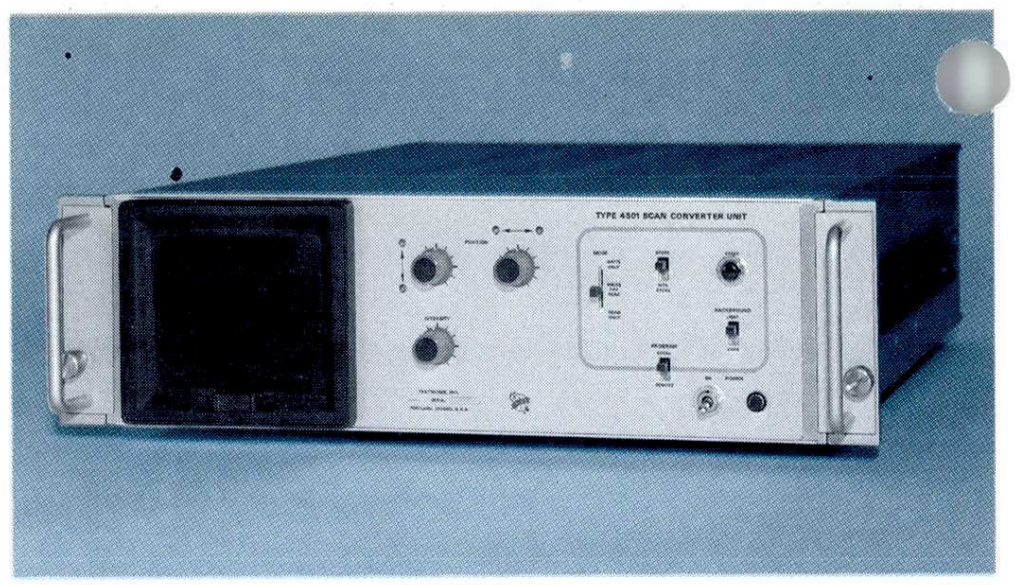
OTHER CHARACTERISTICS

POWER REQUIREMENTS

90 to 136 V AC or 180 to 272 V AC, 48 to 66 Hz, 125 watts maximum at 115 V 60 Hz. Rear-panel selector provides rapid accommodation for 6 line voltage ranges.

TEMPERATURE

Performance characteristics are valid over an operating temperature range of 0°C to +50°C.



Rackmount version, Type R4501

DIMENSIONS AND WEIGHTS

Type 4501	Height	6 in	15.3 cm
	Width	16¾ in	42.6 cm
	Depth	21¼ in	54.0 cm
	Net weight	37¼ lb	17.0 kg
Type R4501	Height	5¼ in	13.4 cm
	Width	19 in	48.3 cm
	Depth	20½ in	52.0 cm
	Net weight	37¼ lb	17.0 kg

INCLUDED STANDARD ACCESSORIES

25-pin connector (131-0570-00); connector cover (200-0821-00); 25-ft, 75-Ω, BNC cable (012-0157-00); 37-pin connector (131-0422-00); connector cover (200-0660-01); 3-to-2 wire adapter (103-0013-00); UHF to BNC adapter (103-0015-00); 3-conductor power cord (161-0010-03); two instruction manuals (070-0943-00). Type R4501 also includes rackmounting hardware.

TYPE 4501 SCAN CONVERTER UNIT **$2500**

TYPE R4501 SCAN CONVERTER UNIT (rackmount model) **$2500**

TELEVISION MONITORS

The Type 4501 Scan Converter Unit provides an output in the form of composite video or modulated RF. Satisfactory displays can be achieved using any good quality TV monitor or receiver. The following monitors are especially recommended for their advanced performance characteristics.

TRANSISTORIZED 17-INCH DISPLAY MONITOR

CONRAC TYPE RVC17/C

Net weight	65 lb	29.5 kg
Shipping weight	79 lb	35.9 kg

Order Tektronix 119-0211-00 ..... $550

TRANSISTORIZED 14-INCH DISPLAY MONITORS

CABINET MODEL: CONRAC TYPE RKC14

Net weight	44 lb	20 kg
Shipping weight	60 lb	27.2 kg

Order Tektronix 119-0194-00 ..... $480

RACKMOUNT MODEL: CONRAC TYPE RLC14

Net weight	51 lb	22.7 kg
Shipping weight	60 lb	27.2 kg

Order Tektronix 119-0195-00 ..... $

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Television Instruments Reference Information

	Page		Page
TYPE 520 NTSC VECTORSCOPE	293	TELEVISION ACCESSORIES	310
TYPE 521 & 522 PAL VECTORSCOPES	297	TYPE 140 NTSC TEST SIGNAL GENERATOR	312
TYPE 528 WAVEFORM MONITOR	302	TYPE 141A PAL TEST SIGNAL GENERATOR	317
TYPE 529 WAVEFORM MONITOR	306	TYPE 142 PAL TEST SIGNAL GENERATOR	321

Tektronix currently offers a series of instruments for the NTSC and PAL color systems. In addition to vectorscopes and waveform monitors, this line has recently been greatly expanded by the introduction of test signal generators.

	NTSC 525/60	PAL 625/50	PAL 525/60
VECTORSCOPE	520	521	522
WAVEFORM MONITOR	529, 528	529 188D* 528 188G	529, 528
SIGNAL GENERATOR	140	141A	142

*Other modified Type 529 Waveform Monitors are available for 625-line, 50-field television standards. Please confer with your Tektronix Field Engineer, Representative or Distributor.

GLOSSARY OF TERMS

APL: Average picture level. The average luminance level of the unblanked portion of a television line.

BRUCH SEQUENCE: An arrangement of color burst signals which assures that the starting polarity of the burst signal is the same at the start of each field for improved stability of color synchronization.

CHROMINANCE: This term is used to indicate both hue and saturation of a color.

CHROMINANCE SIGNAL: In television, the sidebands of the modulated chrominance subcarrier which are added to the monochrome signal to convey color information. The chrominance signal components transmit the qualities of hue and saturation but do not include luminance or brightness.

COLOR BAR: A test signal, typically containing six basic colors—yellow, cyan, green, magenta, red and blue, which is used to check chrominance functions of color TV systems.

COLOR BURST: Refers to a burst of 8 to 10 cycles of subcarrier on the back porch of the composite video signal. This serves as a color synchronizing signal to establish a frequency and phase reference for the chrominance signal.

COLOR SUBCARRIER: The carrier signal whose modulation sidebands are added to the monochrome signals to convey color information.

COMPOSITE VIDEO SIGNAL: The complete video signal. For monochrome, it consists of the picture signal and the blanking and synchronizing signals. For color, additional color synchronizing signals and color picture information are added.

DIFFERENTIAL GAIN: The amplitude change, usually of the color subcarrier, introduced by the overall circuit, measured in dB or per cent, as the picture signal on which it rides is varied from blanking to white level.

DIFFERENTIAL PHASE: The phase change of the color subcarrier introduced by the overall circuit, measured in degrees, as the picture signal on which it rides is varied from blanking to white level.

H RATE: The time for scanning one complete line, including trace and retrace, NTSC equals 1/15734 sec (color) or 63.5 μs.

HUE: The attribute of color perception that determines whether an object is red, yellow, green, blue, purple, or the like. White, black, and gray are not considered as being hues.

LUMINANCE: This indicates the amount of light intensity which is perceived by the eye as brightness.

PAL: Phase alternation line. A system in which the subcarrier derived from the burst signal is switched 180° in phase from one line to the next. This system helps to minimize hue errors which may occur in a color transmission.

SATURATION: The degree to which a color is pure and undiluted by white light, distinguished between vivid and weak shades of the same hue. The less white light in a given color, the greater is its saturation.

STAIRCASE: A video test signal containing several steps at increasing luminance levels. The staircase signal is usually amplitude modulated by the subcarrier frequency and is useful for checking amplitude and phase linearities in video systems.

VITS: Vertical interval test signal (NTSC), vertical insertion test signal (PAL). A signal which may be included during the vertical blanking interval to permit on-the-air testing of video circuitry functions and adjustments.

Television Instruments Reference Information

VECTORSCOPES

The vectorscope has emerged as an essential instrument to those making measurements in color television systems. Vectorscopes are capable of a wide variety of specialized measurements. Differential phase and differential gain are measurable directly, whether the test signal is a full field signal as in out-of-service and proof of performance testing, or a single line per frame vertical interval test signal for in-service testing.

The vectorscope may be thought of as an oscilloscope having a circular time base which has extreme stability (it is determined by the frequency of the color subcarrier). Time delay between two signals can be checked, because the phase difference at any particular frequency can be related to time difference. An example of this is the setup of two color cameras some distance apart. The two signals can be viewed together on a time-shared basis. Any time-delay difference between the two camera links will appear as a phase difference in the vectorial display. This time-delay difference can be determined by noting that 360° on the graticule equals 280 nanoseconds of time in the Type 520 and 522 (225 nanoseconds in the Type 521). The difference can be minimized by adjusting the connecting cable lengths so that there will be no hue or phase difference from one camera to the other.

The chromaticity of any televised material can be measured. Here the measurements are not expressed directly in the customary units in which colorimetry deals, but in terms of the phase angle of the color subcarrier.

WAVEFORM MONITORS

In the field of waveform monitors, Tektronix offers the Type 529 in full rack width and half rack width versions for a variety of mounting arrangements with picture monitors. The Type 529 finds wide acceptance as a transmission test instrument because of its digital line selector and bright, sharp trace which makes it suitable for monitoring vertical interval test signals. For analyzing individual lines per frame of the picture, a variable line selector and line strobe are provided so that the line being examined may be identified on the associated picture monitor.

For a large number of applications, single line viewing is not required, as in camera control and routine monitoring. For these applications, the Type 528 is finding widespread acceptance due to its simplicity and compactness. Two Type 528 instruments occupy only 5¼ inches of rack space, yet the screen size is 8 x 10 cm.

TELEVISION TEST SIGNAL GENERATORS

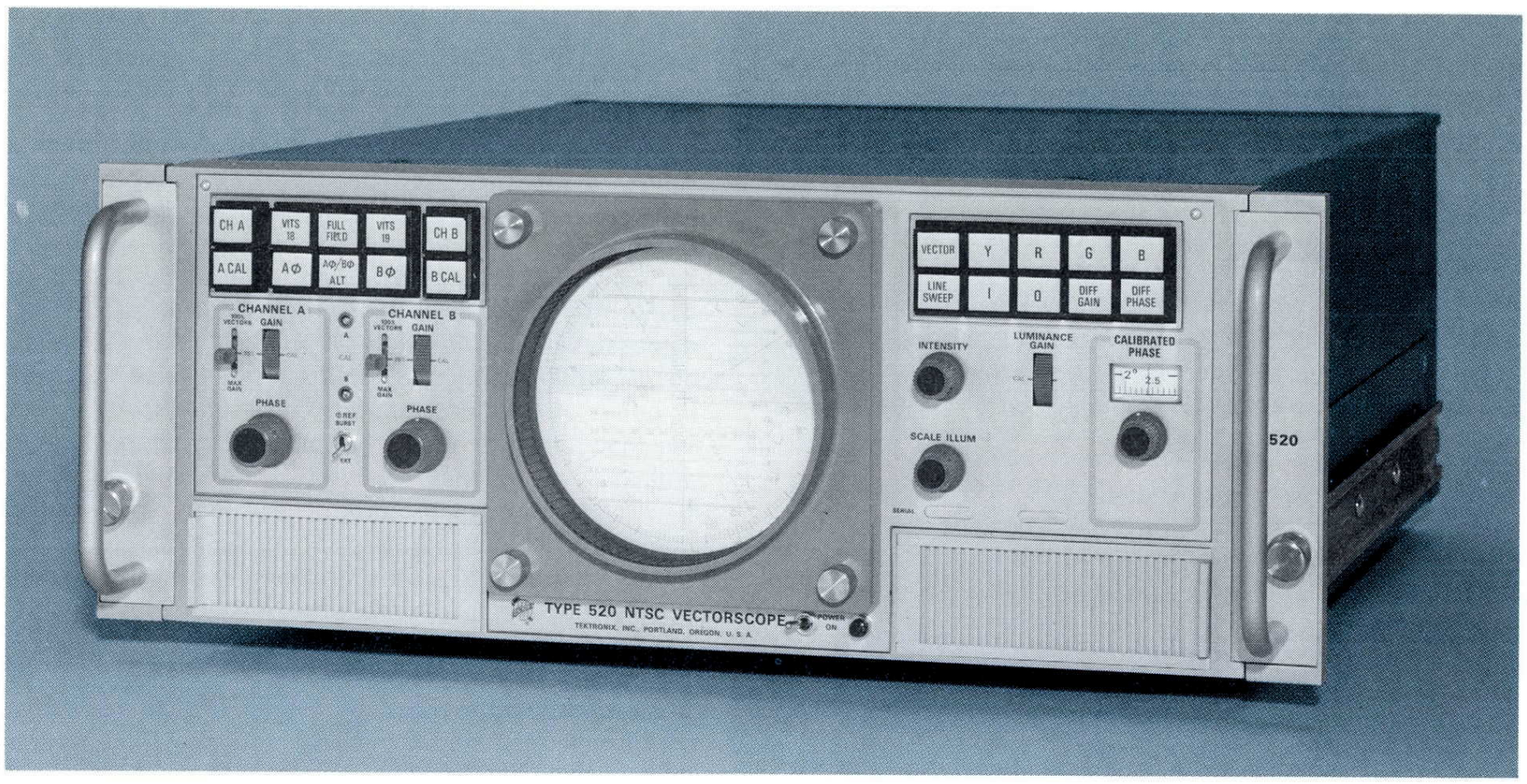
Tektronix has Test Signal Generators available for both NTSC and PAL color TV systems. The instruments are all solid-state utilizing digital integrated circuits to achieve the stability, accuracy and reliability expected of instruments which generate test signals against which system performance can be evaluated. They provide operating capabilities normally found in much higher priced generators.

RETURN LOSS BRIDGE

The new 75-ohm Return Loss Bridge was developed to assess the performance of television transmission lines and their terminal equipments in carrying television signals without picture impairment. The Return Loss Bridge measures quantitatively the energy reflected in a transmission system due to impedance mismatching at or before the termination. Unlike fast pulse systems, the return loss technique uses standard TV test signals so that energy reflections at frequencies above those of interest are not measured. In this way, results are obtained which are meaningful in assessing transmission quality for television. Fast pulse techniques on the other hand locate impedance discontinuities when the return loss technique has determined that there are relevant reflections at video frequencies.

The Tektronix Return Loss Bridge is used in conjunction with the Type 1A5 or 7A13 Differential Plug-In Units. The Return Loss System is specified at —54 dB over the full 10 MHz bandwidth of the system. Since —46 dB is equivalent to an impedance discontinuity of less than 0.5%, the bridge provides more resolution than is usually required.

520 NTSC Vectorscope R520



- ***PUSH-BUTTON OPERATING CONVENIENCE***
- ***AMPLITUDE CALIBRATED DISPLAYS***
- ***LUMINANCE AMPLITUDE, CHROMINANCE PHASE AND AMPLITUDE, DIFFERENTAL PHASE AND DIFFERENTIAL GAIN MEASUREMENTS***
- ***THE LUMINANCE CHANNEL AND THE LINE-RATE TIME BASE PERMIT DECODED R, G, B and Y DISPLAYS***
- ***ALL SILICON SOLID-STATE, COOL, QUIET OPERATION***

The Tektronix Type 520 NTSC Vectorscope is designed to measure luminance amplitude, and chrominance amplitude and phase of the NTSC composite color television signal. Self-canceling pushbutton switches permit rapid selection of displays for quick analysis of television signal characteristics, and to check Vectorscope calibration. All solid-state circuitry provides low power consumption and cool, quiet operation.

Dual inputs provide time-shared displays for comparison of input-output signal phase and gain distortion. A chrominance channel is provided which demodulates the chrominance signal to obtain color information from the composite video signal for use in VECTOR, LINE SWEEP, R, G, B, I, Q, Differential Gain (dA) and Differential Phase (dϕ) displays. A luminance channel separates and displays the luminance (Y) component of the composite color signal. The Y component is combined with the output of the chrominance demodulators for R, G and B displays at a line rate.

A digital line selector permits the display of a single line Vertical Interval Test Signal from a selected line of either field 1 or field 2.

VECTOR PRESENTATION

The vector presentation graphically displays the relative phase and amplitude of the chrominance signal on polar coordinates. To identify these coordinates the graticule (see fig 1) has points which correspond to the proper phase and amplitude of the primary and complementary colors: R (Red), B (Blue), G (Green); Cy (Cyan), Y_L (Yellow) and M_G (Magenta).

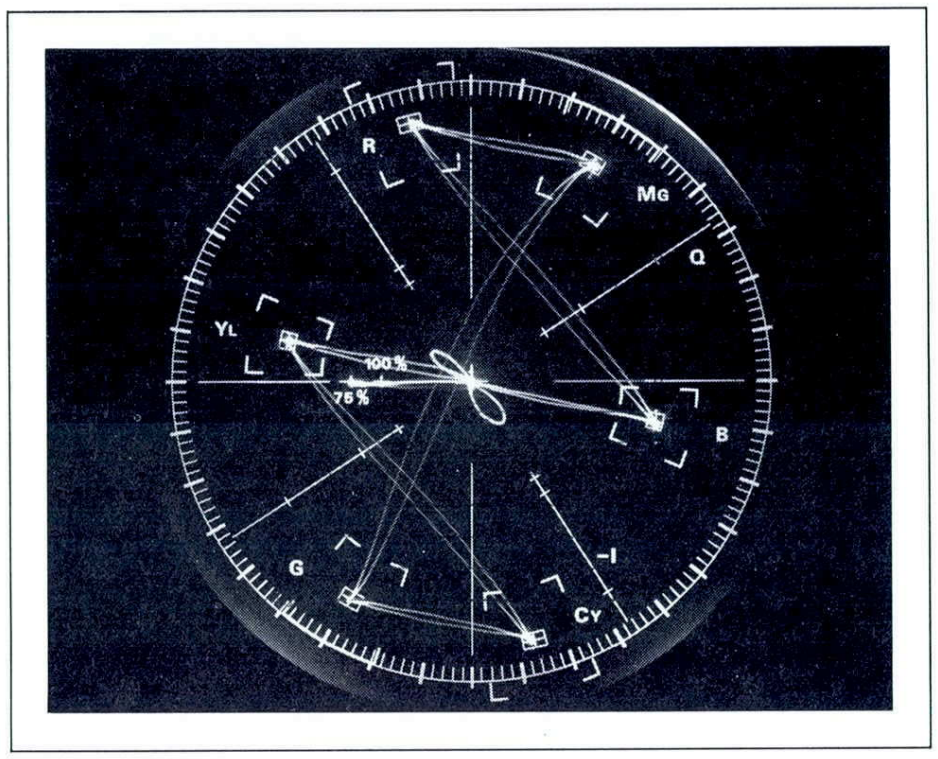


Fig 1—Vector display—full field color bars, 75% amplitude, 100% white reference, 10% set-up. Conforms to EIA standard RS189. Type 140 NTSC Test Signal Generator used as a signal source.

Any errors in the color encoding, video tape recording or transmission processes which change these phase and/or amplitude relationships cause color errors in the television receiver picture. The polar coordinate type of display such as that obtained on the Type 520 CRT has proved to be the best method for portraying these errors.

The polar display permits measurement of hue in terms of relative phase of the chrominance signal with respect to the color burst. Saturation is expressed in terms of the displacement from center (radial length) toward the color point which corresponds to 75% (or 100%) saturation of the particular color being measured.

The outer boxes around the color points correspond to phase and amplitude error limits per FCC requirements (±10°, ±20%). The inner boxes indicate ±2.5° and 2.5 IRE units and correspond to phase and amplitude error limits per EIA specification RS-189, amended for 7.5% setup.

An internally generated test circle matched with the vector graticule verifies quadrature accuracy, horizontal to vertical gain balance and gain calibration for chrominance signal amplitude measurements. Two methods of measuring phase-shift are provided. Large phase-shifts can be accurately read from the parallax-free vector graticule. A precision calibrated phase shifter with a range of 30°, spread over 30 inches of dial length, is provided for measuring small phase-shifts.

LINEAR-SWEEP PRESENTATION

The linear time base operates at the line rate. Color sig[illegible] are demodulated along any desired axis, I, Q, R-Y, B-Y, [illegible] and displayed at the line rate on a linear time base.

DUAL DISPLAY

In dual-channel operation, successive samples of channels A and B are displayed on a time-shared basis. The switching rate is locked to horizontal sync and switching transients are blanked. Input-output signals from video equipment can be conveniently compared on channel A and B for phase and/or amplitude distortion. The subcarrier processing channel contains two uncalibrated 0° to 360° phase-shifters and one 30° CALIBRATED PHASE shifter. While viewing channel A or B, either of the uncalibrated phase-shifters, Aϕ or Bϕ, can be switched into the subcarrier processing channel. Aϕ and Bϕ will lock to channel A and B respectively, when A and B channel are time-shared, permitting independent phase control of channel A and B displays. Phase shifts caused by unequal signal paths are easily cancelled, leaving only phase and amplitude distortion caused by equipment deficiencies. Video cable lengths can be accurately matched for time delay at color subcarrier frequency to less than 0.5° phase difference. Accurate amplitude measurements of chrominance and luminance are provided from the CRT. An internal 1-V luminance amplitude calibration test signal is provided to check the gain accuracy of channel A and B amplifiers and the luminance channel.

DIFFERENTIAL GAIN AND DIFFERENTIAL PHASE MEASUREMENTS

The two main chrominance-signal distortions are differential gain and differential phase. Both can be measured on t[illegible]

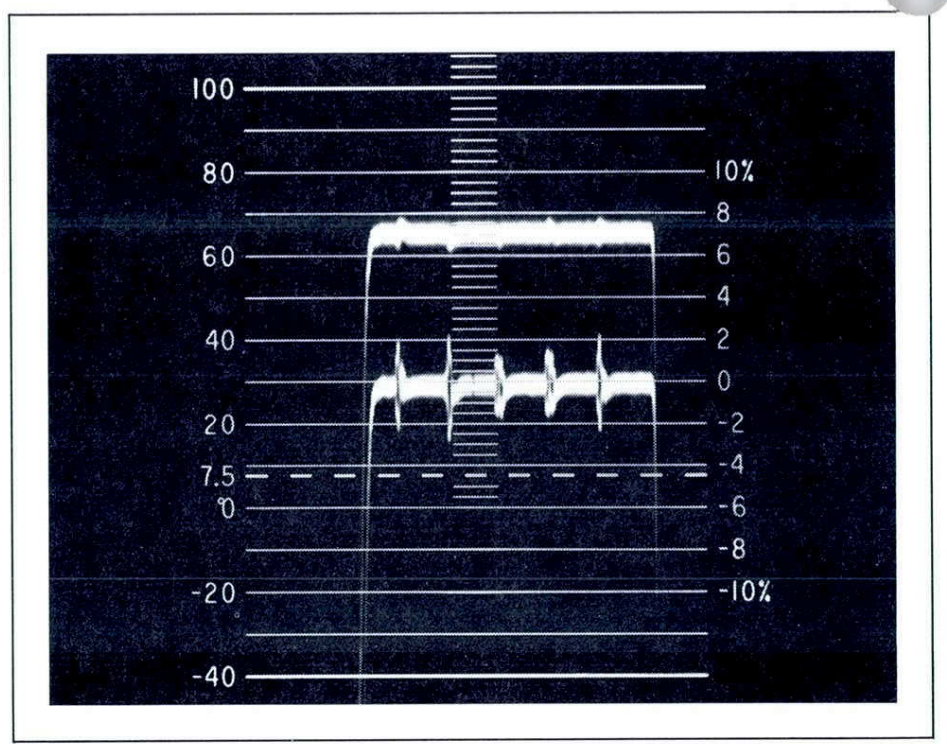


Fig 2—Differential Gain display from the Type 520 using the Type 140 NTSC Test Signal Generator. Lower trace, luminance is on. Upper trace, luminance is off. Minor divisions of graticule indicate .5% Differential Gain. Double exposure.

Type 520 Vectorscope. Differential gain (fig 2) is a change in color subcarrier amplitude as a function of luminance. In the reproduced color picture, the saturation will be distorted in the areas between the light and dark portions of the scene. The IRE graticule major divisions represent % of volt[illegible] gain or loss when making a differential gain measuremen[illegible] The 520 permits differential gain measurements with accuracy to better than 1%.

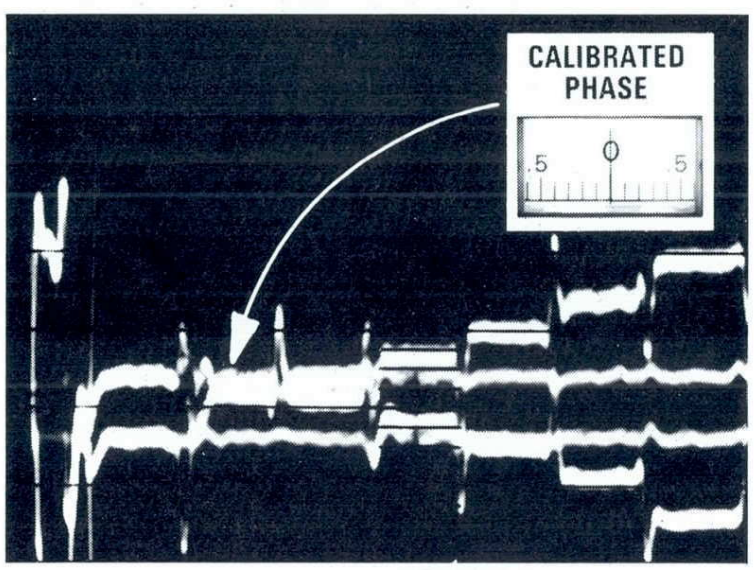
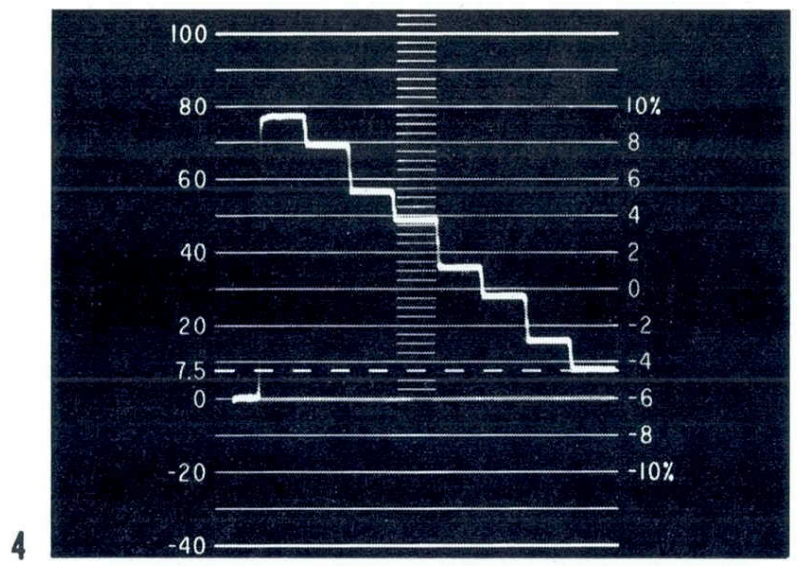


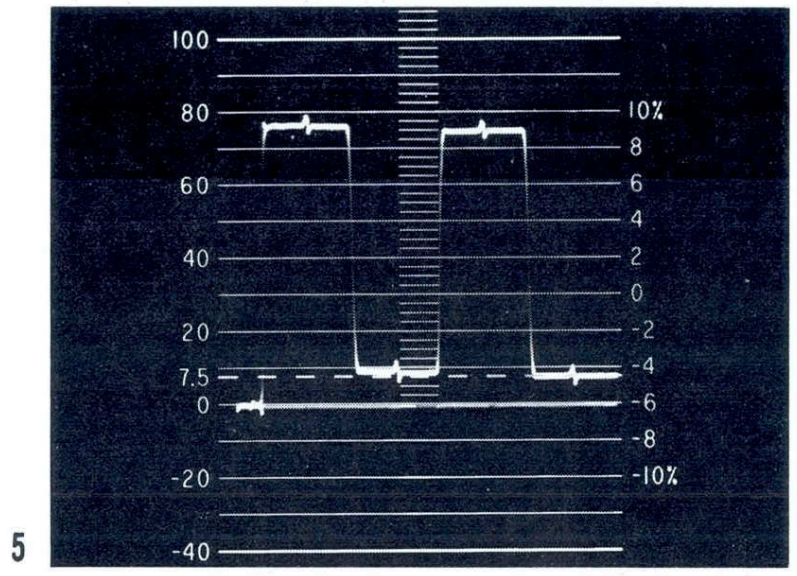
Fig 3—Differential Phase of a typical video amplifier. The trace overlay technique provides excellent resolution for measuring small phase changes. From reference point in top photo (lst step of staircase signal overlayed) to point of measure in second photo (6th step overlayed) represents 2.1° differential phase distortion.

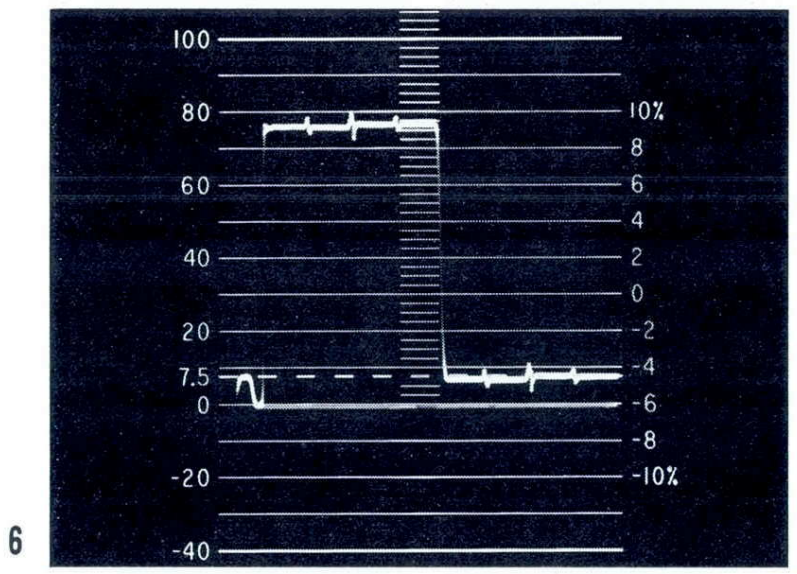
Differential phase (fig 3) is a phase modulation of the chrominance signal by the luminance signal. In the reproduced color picture, the hue will vary with scene brightness. Differential gain and differential phase may occur separately or together. The causes of these distortions are amplitude non-linearity and time delay that are not independent of the signal level. Differential phase is read from the precision calibrated phase shift control. Dial resolution is excellent with 1° phase shift represented by approximately 1 inch of dial movement. The vertical deflection of the display is greatly magnified and inverted on alternate lines allowing the use of a trace overlay technique and the slide-back method for measuring small phase changes. The CALIBRATED PHASE control provides direct readout of differential phase. Using the standard linearity test signal, differential phase of 0.2° can be measured. Reference burst is selectable, internal or external.

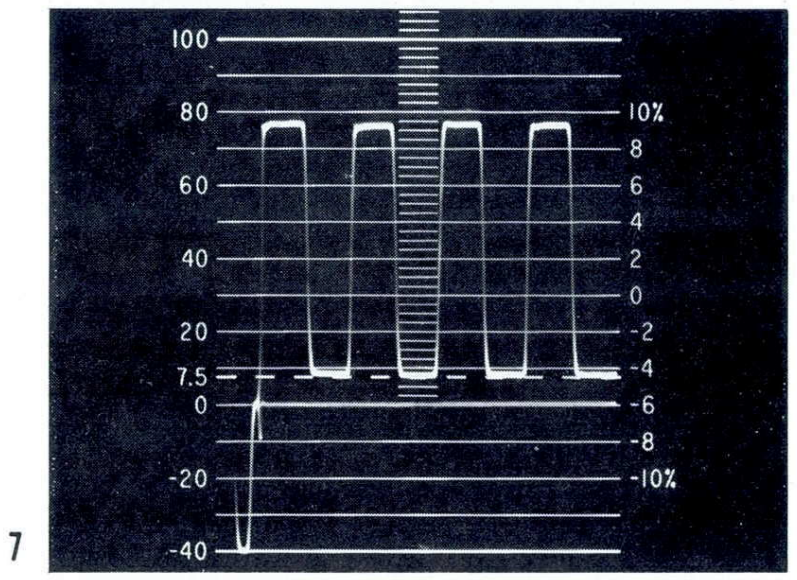
RED (R), GREEN (G), BLUE (B) AND LUMINANCE (Y) OBSERVATIONS

The Type 520 provides a luminance channel which permits the separation and display of the luminance (Y) component from the composite color signal (fig 4). The Y component can also be combined with the output of the chrominance demodulators for R, G and B displays at a line rate (fig 5, 6, 7). Amplitude measurements of color signal components can be made with an accuracy of 3%.









75% amplitude EIA Color Bar Signal. Line-sweep displays of Luminance (fig 4), decoded Red (fig 5), decoded Green (fig 6), and decoded Blue (fig 7). Displays photographed with a Tektronix C-27-549 Camera, using a Tektronix Type 140 NTSC Test Signal Generator as a source.

VERTICAL INTERVAL TEST SIGNAL OBSERVATION

Vertical Interval Test Signals from preselected lines of either field 1 or field 2 can be displayed on the Type 520 Vectorscope.

Binary counters operate in conjunction with the field selector to select lines in either field that may carry suitable test signals. These circuits enable the Vectorscope to be used for measuring differential gain and differential phase from test signals transmitted in the vertical blanking interval of color broadcasts.

Normally, lines 18 and 19 in either field 1 or field 2 are selected by means of the VITS 18 and VITS 19 pushbuttons in conjunction with the FIELD switch. Internal quick-disconnect jumper wires permit selecting any line from 7 through 21 of either field. Intensity and focus are automatically adjusted for optimum viewing of VITS.

GRATICULE

Two separate graticules provide references for vector and line sweep displays. The parallax-free vector graticule, or the IRE graticule, is automatically selected and edge-lighted concurrent with operating mode selection.

Z AXIS INPUT

The Z-AXIS INPUT connector accepts external trace-brightening pulses for intensifying a portion of the display during the time of interest. A 1-V negative-going pulse is required.

VIDEO INPUTS

Dual input BNC connectors (fig 8) for each channel permit 75-Ω loop-through operation with a return loss greater than 46 dB* to 5 MHz. Amplitude range is 0.7 V to 1.4 V VIDEO (sync tip to peak white).

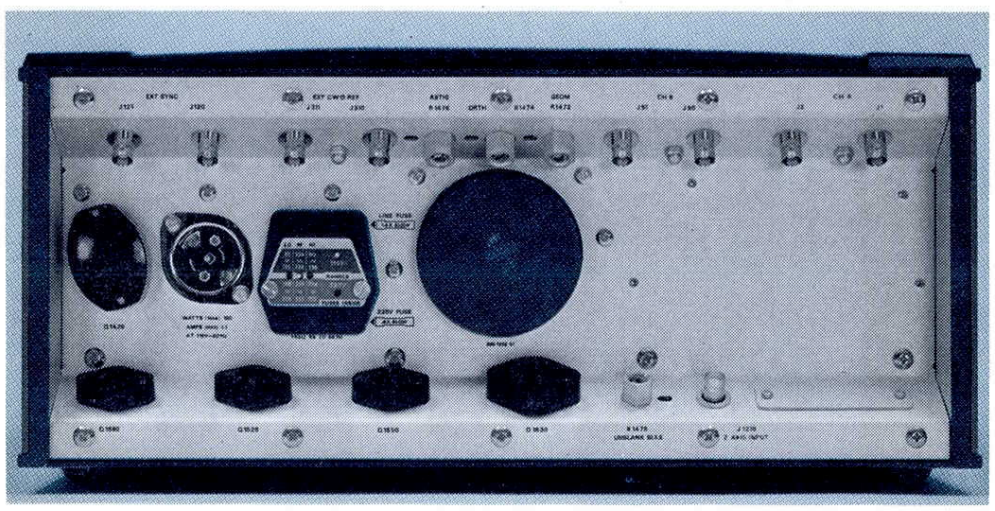


Fig 8—Rear view of 520 Vectorscope. The mounting angle of the coax connectors permit connecting cables to leave the instrument without protruding excessively and with a minimum of clearance space required.

POWER REQUIREMENTS

90 to 136 VAC or 180 to 272 VAC, 47 to 63 Hz, 95-watts maximum at 115 V and 60 Hz. Rear panel selector provides rapid accommodation for six line-voltage ranges.

ENVIRONMENTAL CAPABILITIES

Ruggedly designed to withstand temperature and altitude variations, vibration, shock, and transportation. Listed instrument characteristics are valid over a temperature range of 0° C to +50° C ambient.

MECHANICAL CHARACTERISTICS

The Type 520 Vectorscope is available in two mechanical configurations. A cabinet model (Type 520) (fig 9) and a rackmount model (Type R520). Both instruments are electrically identical. The R520 mounts in a 19-inch rack and is provided with slide-out chassis tracks for convenient access to internal components.

*Exceeds CCIR recommendation 451-2, paragraph 3.1 and 3.2

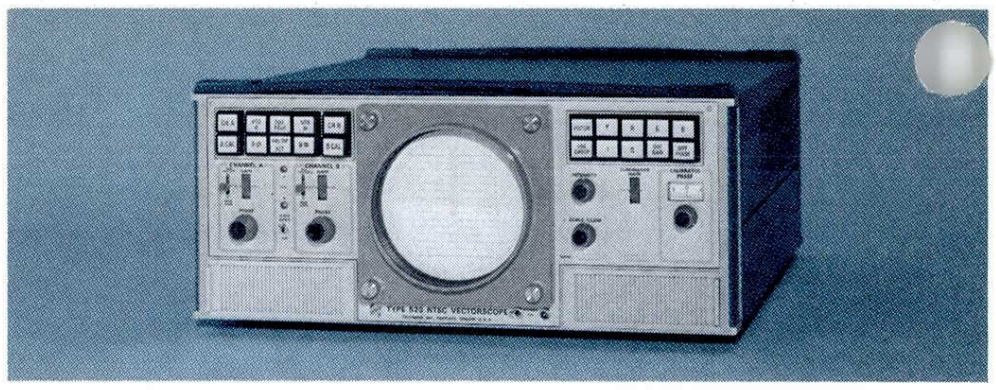


Fig 9—Cabinet model.

DIMENSIONS AND WEIGHTS

TYPE 520	Height	7 in	17.8 cm
	Width	16⅞ in	42.9 cm
	Depth	19⅛ in	48.7 cm
	Net weight	33 lb	15 kg
TYPE R520	Height	7 in	17.8 cm
	Width	19 in	48.3 cm
	Depth	19¾ in	50.2 cm
	Net weight	33 lb	15 kg
Domestic shipping weight		≈61 lb	≈27.7 kg
Export-packed weight		≈82 lb	≈37.3 kg

INCLUDED STANDARD ACCESSORIES

TYPE 520: Smoke-gray filter, installed (378-0581-00); camera gasket and mounting screws (016-0114-00); power cord (161-0036-00); 3 to 2-wire adapter (103-0013-00); 2 instruction manuals (070-0639-01).

TYPE R520. Same as Type 520 but includes rackmounting hardware, and mounting tracks (351-0101-00).

ORDERING INFORMATION

Cabinet model, order TYPE 520 NTSC VECTORSCOPE . . . . . $2[illegible]

Rackmount model, order TYPE R520 NTSC VECTORSCOPE $2175

UHF connectors are optional and may be specified without extra cost.

OPTIONAL ACCESSORIES

75-Ω VOLTAGE STEP-UP TERMINATION

The 75-Ω Voltage Step-Up Termination provides a X5 increase in chrominance amplitude and permits Differential Gain and Differential Phase measurements to be made to a higher degree of accuracy when used with a Tektronix Vectorscope. Input impedance to the termination is a constant 75 Ω. Use of the termination requires a source of external sync to the Vectorscope.

For use with Type 520 Vectorscope

UHF connectors, order 011-0100-00 . . . . . $27.50
BNC connectors, order 011-0100-01 . . . . . $27.50

SINGLE SIDEBAND CHROMA AMPLITUDE CORRECTOR

The Single Sideband Chroma Amplitude Corrector is designed for use with a Tektronix Vectorscope in transmitter applications where a vestigial sideband signal is being demodulated with a detecting diode. The corrector provides a X2 increase in chrominance amplitude and passes luminance components with little or no attenuation. Input impedance is 75 Ω.

For use with Type 520 Vectorscope

UHF connectors, order 011-0107-00 . . . . . $27.50
BNC connectors, order 011-0107-01 . . . . . $27.50

C-27 TRACE RECORDING CAMERA

f/1.9, 1:0.5 lens; Polaroid Land* Pack-Film back.

Order C-27-549 . . . . . $[illegible]
Type 520 to C-27 Camera Adapter, order 016-0225-02 . . $[illegible]

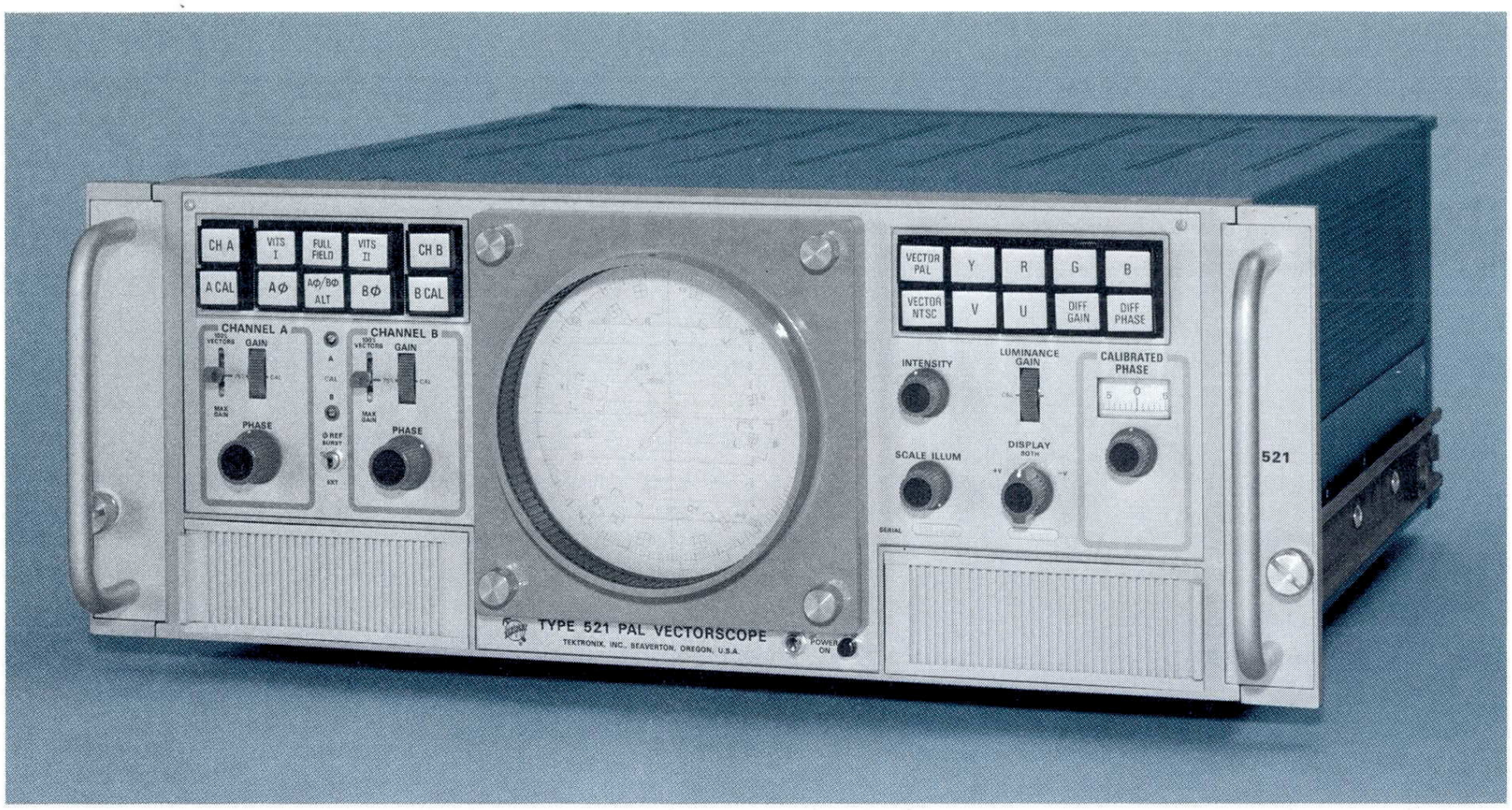
*Registered Trademark, Polaroid Corporation

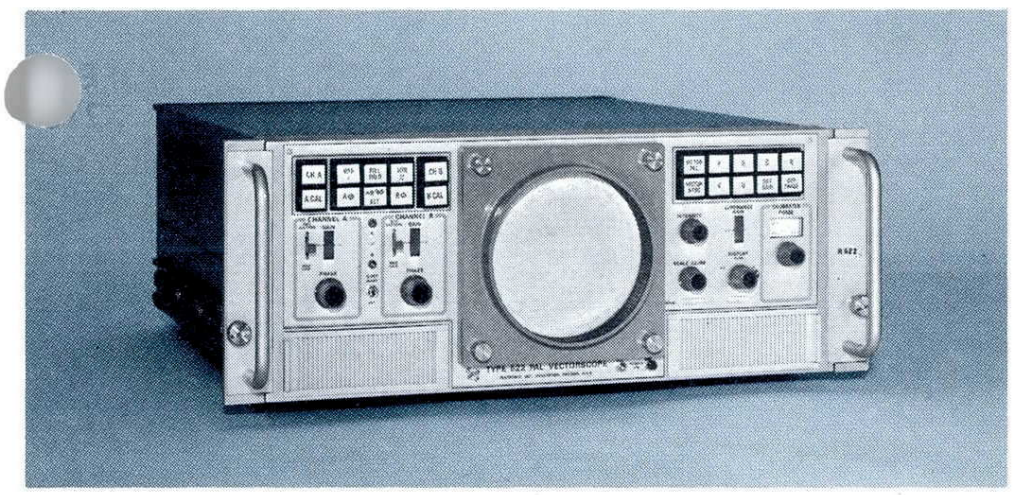
U.S. Sales Prices FOB Beaverton, Oregon

Please refer to Terms and Shipment, General Information page.

NEW

521/522 PAL Vectorscope R521/R522





- ***PUSH-BUTTON OPERATING CONVENIENCE***
- ***AMPLITUDE CALIBRATED DISPLAYS***
- ***LUMINANCE AMPLITUDE, CHROMINANCE PHASE AND AMPLITUDE, DIFFERENTIAL PHASE AND DIFFERENTIAL GAIN MEASUREMENTS***
- ***THE LUMINANCE CHANNEL AND THE LINE-RATE TIME BASE PERMIT DECODED R, G, B and Y DISPLAYS***
- ***ALL SILICON SOLID-STATE, COOL, QUIET OPERATION***

The Tektronix Types 521 and 522 PAL Vectorscopes are designed to measure luminance amplitude, and chrominance phase and amplitude of the PAL composite color television signal. Both units are identical in concept and operation. The Type 521 PAL Vectorscope is designed for 625 line 50 field PAL Color TV signals utilizing a color subcarrier frequency of 4.43361875 MHz and is calibrated to observe video signals with 0 set-up level. The Type 522 PAL Vectorscope* is designed for 525 line 60 field PAL Color TV signals utilizing a color subcarrier frequency of 3.575611 MHz and is calibrated to observe video signals with 50-mV set-up level. Self-canceling push-button switches permit rapid selection of displays for quick analysis of television signal characteristics, and to check Vectorscope calibration. All solid-state circuitry provides low power consumption and cool, quiet operation.

Dual inputs are provided permitting time-shared displays for comparison of input-output signal phase and gain distortion. A chrominance channel is provided which demodulates the chrominance signal to obtain color information from the composite video signal for use in VECTOR PAL, VECTOR NTSC, R, G, B, U, V, Differential Gain and Differential Phase displays. A luminance channel separates and displays the luminance (Y) component of the composite color signal. The Y component is combined with the output of the chrominance demodulators for R, G and B displays at a line rate.

A digital line selector permits the display of a single line Vertical Insertion Test Signal from a selected line of either field 1 or field 2.

*The Type 522 PAL Vectorscope is for use with the PAL system currently used in Brazil only.

NEW

521/522 PAL Vectorscope R521/R522

VECTOR PRESENTATION

The vector presentation graphically displays the relative phase and amplitude of the chrominance signal on polar coordinates. To identify these coordinates the graticule (see fig 1) has points which correspond to the proper phase and amplitude of the primary, complementary and conjugate chrominance vectors: Red (R) (r), Green (G) (g), Blue (B) (b), Cyan (Cy) (cy), Magenta (Mg) (mg) and Yellow (Yl) (yl).

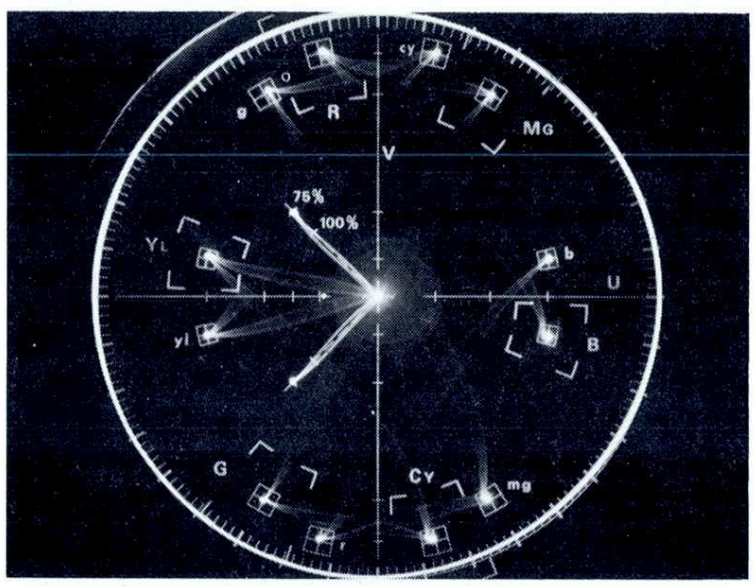


Fig 1A—Vector PAL presentation of PAL color bar signal.

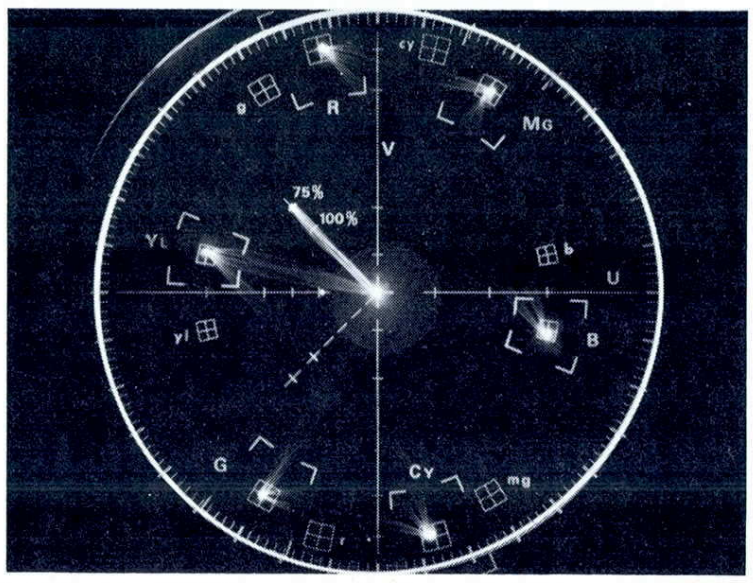


Fig 1B—Vector NTSC presentation of PAL color bar signal.

Any errors in the color encoding, video tape recording or transmission processes which change these phase and/or amplitude relationships cause color errors in the television receiver picture. The polar coordinate type of display such as that obtained on a vectorscope has proved to be the best method for portraying these errors.

The polar display permits measurement of hue in terms of relative phase of the chrominance signal with respect to the color burst. Saturation is expressed in terms of the displacement from center (radial length) toward the color point which corresponds to 75% (or 100%) saturation of the particular color being measured.

The outer boxes around the color points correspond to phase and amplitude error limits (±10°, ±20%). The inner boxes indicate ±3° phase angle and ±5% amplitude.

(+V), (+V and −V) and (−V) vector displays are provided, permitting observation of the 135° and 235° burst-related color information, individually or combined.

An internally generated test circle matched with the vector graticule verifies quadrature accuracy, horizontal to vertical gain balance and gain calibration for chrominance signal amplitude measurements. Two methods of measuring phase-shift are provided. Large phase-shifts can be accurately read from the parallax-free vector graticule. A precision calibrated phase shifter with a range of 30°, spread over 30 inches of dial length, is provided for measuring small phase-shifts.

LINEAR-SWEEP PRESENTATION

The linear time base operates at the line rate. Color signals are demodulated along any desired axis, U, V, etc. and displayed at the line rate on a linear time base.

DUAL DISPLAY

In dual-channel operation, successive samples of channels A and B are displayed on a time-shared basis. The switching rate is locked to horizontal sync and switching transients are blanked. Input-output signals from video equipment can be conveniently compared on channel A and B for phase and/or amplitude distortion. The subcarrier processing channel contains two uncalibrated 0° to 360° phase-shifters and one 30° CALIBRATED PHASE shifter. While viewing channel A or B, either of the uncalibrated phase-shifters, Aϕ or Bϕ, can be switched into the subcarrier processing channel. Aϕ or Bϕ will lock to channel A and B respectively, when A and B channel are time-shared, permitting independent phase control of channel A and B displays. Phase shifts caused by unequal signal paths are easily cancelled, leaving only phase and amplitude distortion caused by equipment deficiencies. Video cable lengths can be accurately matched for time delay at color subcarrier frequency to less than 0.5° phase difference. Accurate amplitude measurements of chrominance and luminance are provided from the CRT. An internal 1-V luminance amplitude calibration test signal is provided to check the gain accuracy of channel A and B amplifiers and the luminance channel.

DIFFERENTIAL GAIN AND DIFFERENTIAL PHASE MEASUREMENTS

The two main chrominance-signal distortions are differential gain and differential phase. Both can be measured on the Types 521 and 522 PAL Vectorscopes. Differential gain (fig 2) is a change in color subcarrier amplitude as a function of luminance. In the reproduced color picture, the saturation will be distorted in the areas between the light and dark portions of the scene. The luminance graticule major divisions represent % of voltage gain or loss when making a differential gain measurement. The 521 and 522 PAL Vectorscopes permit differential gain measurements with accuracy to better than 1%.

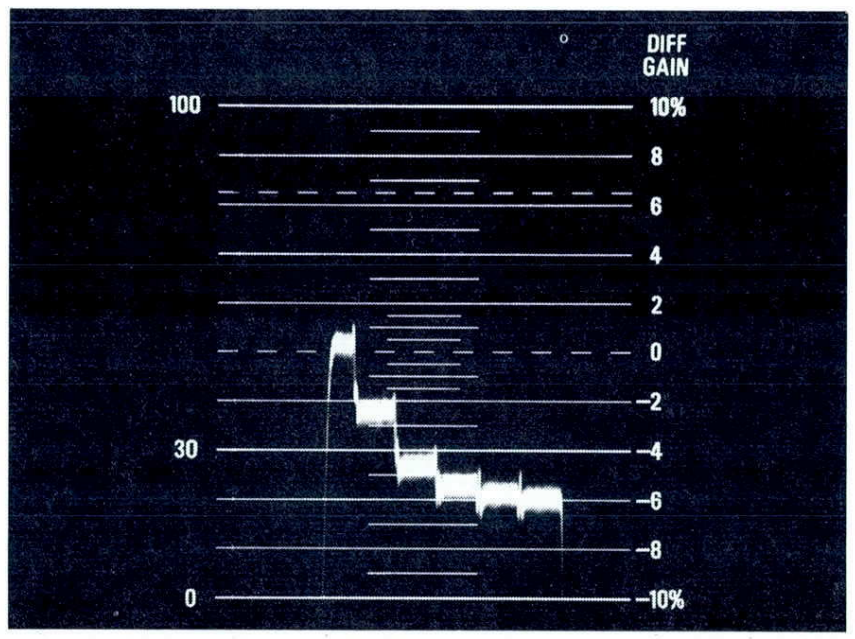
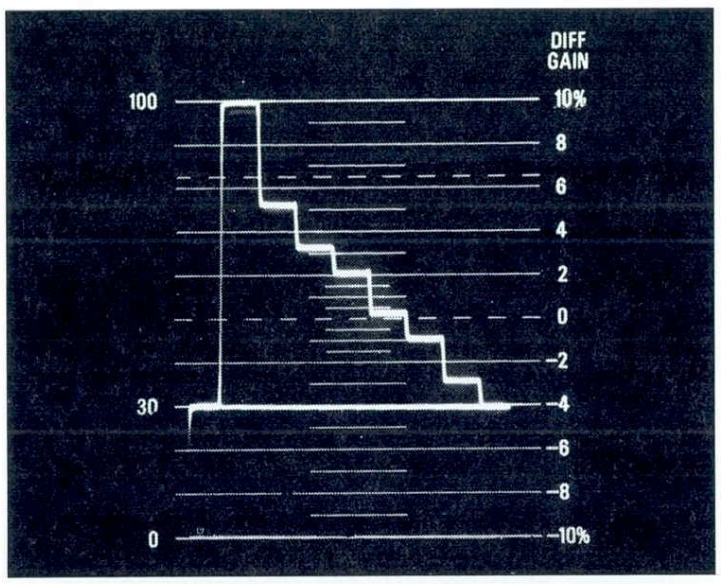


Fig 2—Type 521 PAL and Type 141A system being used to measure differential gain of a typical cascade of video amplifiers. Indicated differential gain is 6½%.



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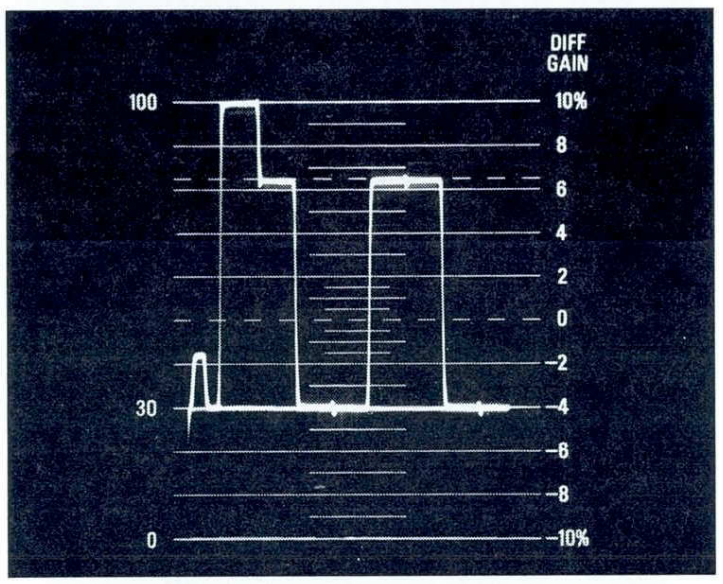

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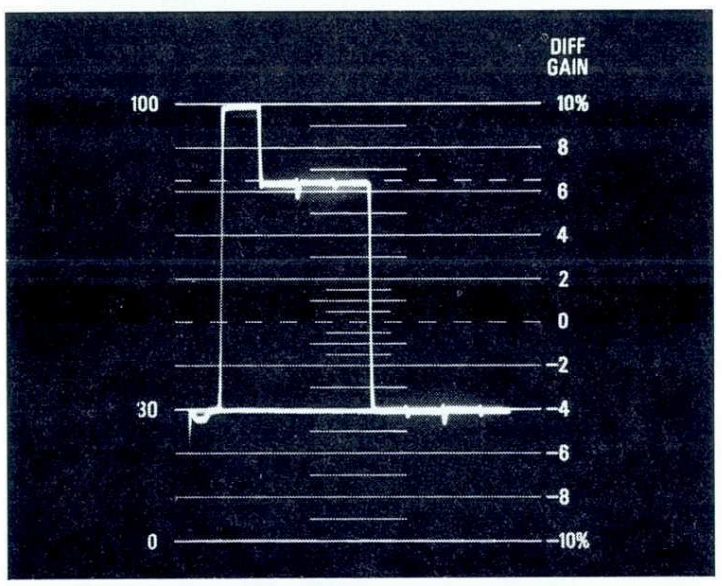


5

6

Line sweep presentations of Luminance (signal sequence; white, yellow, cyan, green, magenta, red, blue, and black, fig 3), decoded Red (fig 4), decoded Green (fig 5), and decoded Blue (fig 6), components of the PAL color bar signal. Photos were taken using a Type 141A PAL Television Test Signal Generator, a Type 521 PAL Vectorscope, and a C-27-549 Camera.

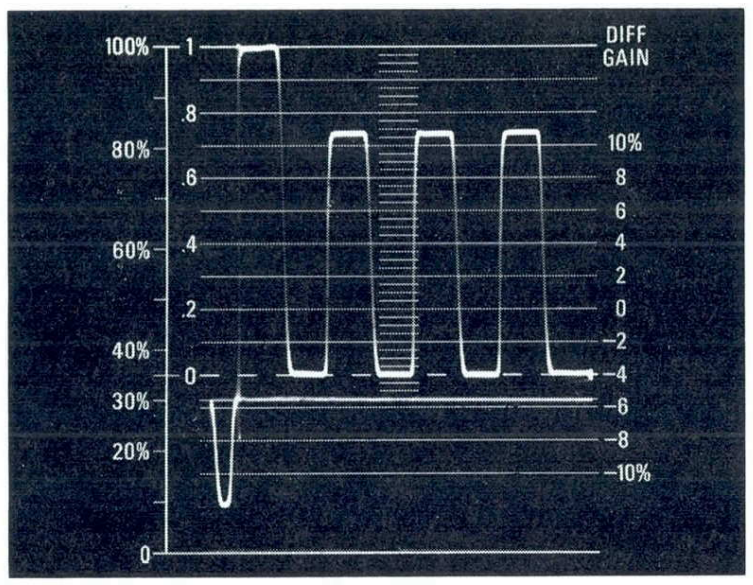


Fig 7—Line-sweep presentation of decoded Blue component of PAL color-bar signal.

Note difference between Type 521 and Type 522 graticules, the Type 522 graticule is designed for 50 mV set-up.

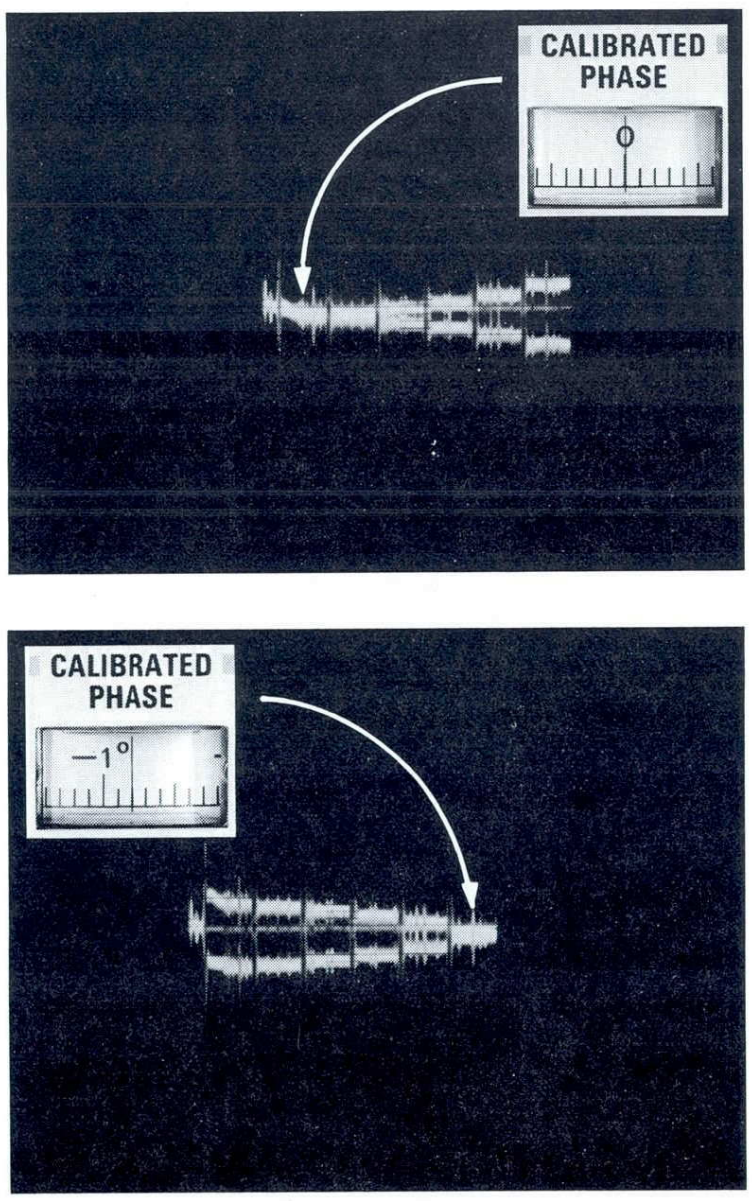


Fig 8—Differential Phase presentation using a modulated staircase signal. A trace overlay technique provides excellent resolution for measuring small phase changes. From reference point in top photo (1st step of staircase signal overlayed) to point of measure in bottom photo (6th step overlayed) represents 1.2° differential phase distortion.

Differential phase (fig 8) is a phase modulation of the chrominance signal by the luminance signal. Differential phase may result in picture impairment.

NEW

521/522 PAL Vectorscope R521/R522

Differential gain and differential phase may occur separately or together. The causes of these distortions are amplitude non-linearity and time delay that are not independent of the signal level. Differential phase is read from the precision calibrated phase shift control. Dial resolution is excellent with 1° phase shift represented by approximately 1 inch of dial movement. The vertical deflection of the display is greatly magnified and inverted on alternate lines allowing the use of a trace overlay technique and the slide-back method for measuring small phase changes. The CALIBRATED PHASE control provides direct readout of differential phase. Using the standard linearity test signal, differential phase of 0.2° can be measured. Reference burst is selectable, internal or external.

RED (R), GREEN (G), BLUE (B) AND LUMINANCE (Y) OBSERVATIONS

The Types 521 and 522 PAL Vectorscopes provide a luminance channel which permits the separation and display of the luminance (Y) component from the composite color signal (fig 3). The Y component can also be combined with the output of the chrominance demodulators for R, G and B displays at a line rate (fig 4, 5, 6). Amplitude measurements of color signal components can be made with an accuracy of 3%.

VERTICAL INSERTION TEST SIGNAL OBSERVATION

Vertical Insertion Test Signal from preselected lines of either field 1 and 3 or field 2 and 4 can be displayed on the Types 521 and 522 PAL Vectorscopes.

Binary counters operate in conjunction with the field selector to select lines in either field that may carry suitable test signals. These circuits enable the Vectorscope to be used for measuring differential gain and differential phase from test signals transmitted in the vertical blanking interval of color broadcasts.

Specific lines are selected by means of the VITS I and VITS II push buttons. Vectorscopes normally are shipped from the factory with the following lines selected by these switches:

	(VITS I) FIELDS 1 and 3	(VITS II) FIELDS 2 and 4
Type 521/R521	lines 17 and 18	lines 330 and 331
Type 522/R522	lines 15 and 16	lines 278 and 279

Internal quick-disconnect jumper wires permit selecting any line from 4 through 22 or 316 through 335 with the Type 521, and any line from 12 through 18 or 275 through 281 with the Type 522. Intensity and focus are automatically adjusted for optimum viewing of VITS.

GRATICULE

Two separate graticules provide references for vector and line sweep displays. The parallax-free PAL vector graticule, or the luminance graticule, is automatically selected and edge-lighted concurrent with operating mode selection.

Z AXIS INPUT

The Z-AXIS INPUT connector accepts external trace-brightening pulses for intensifying a portion of the display during the time of interest. A 1-V negative-going pulse is required.

VIDEO INPUTS

Dual BNC input connectors (fig 9) for each channel permit 75-Ω loop through operation with a return loss greater than 46 dB* to 5 MHz. Amplitude range is 0.7 V to 1.4 V VIDEO (sync tip to peak white).

*Exceeds CCIR recommendation 451-2, paragraph 3.1 and 3.2

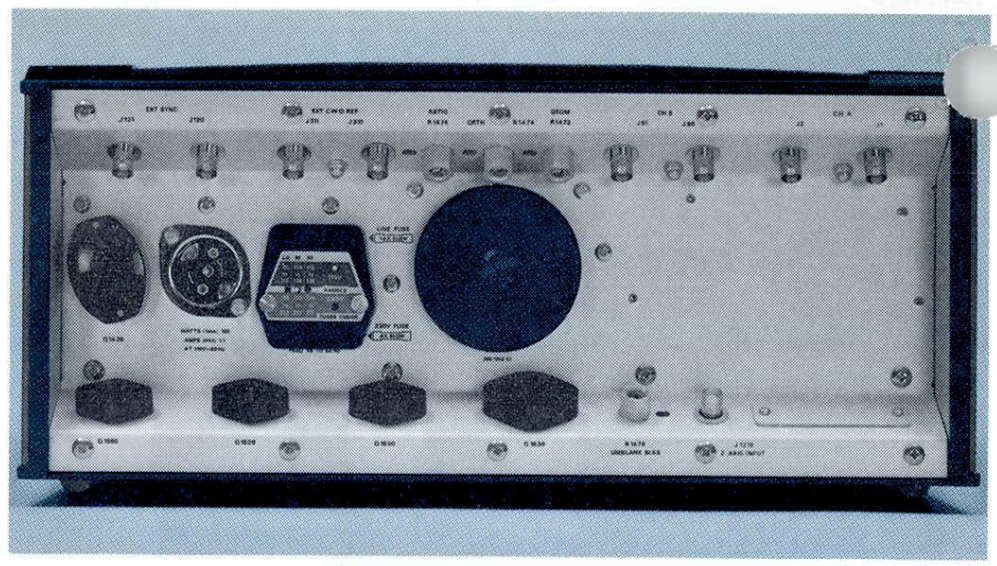


Fig 9—Rear view of Type 521 PAL Vectorscope (Type 522 is identical). The mounting angle of the coax connectors permits connecting cables to leave the instrument without protruding excessively and with a minimum of clearance space required.

POWER REQUIREMENTS

90 to 136 VAC or 180 to 272 VAC, 47 to 63 Hz, 95 watts maximum at 115 V and 60 Hz. Rear panel selector provides rapid accommodation for six line-voltage ranges.

ENVIRONMENTAL CAPABILITIES

Listed instrument characteristics are valid over a temperature range of 0°C to +50°C ambient.

MECHANICAL CHARACTERISTICS

The Types 521 and 522 PAL Vectorscopes are available in two mechanical configurations, a cabinet model (fig 10) and a rackmount model. Both instruments are electrically identical. The Types R521 and R522 mount in a 19-inch rack and are provided with slide-out chassis tracks for convenient access to internal components.

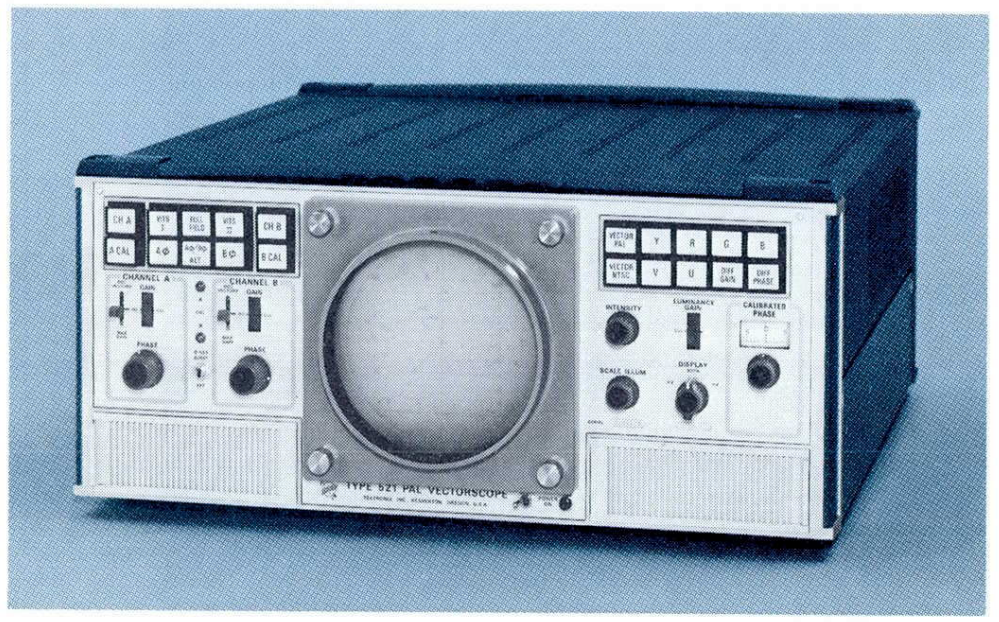


Fig 10—Cabinet model.

DIMENSIONS AND WEIGHTS

Types 521 and 522	Height	7 in	17.8 cm
	Width	16⅞ in	42.9 cm
	Depth	19⅛ in	48.7 cm
	Net weight	33 lb	15 kg
Types R521 and R522	Height	7 in	17.8 cm
	Width	19 in	48.3 cm
	Depth	19¾ in	50.2 cm
	Net weight	33 lb	15 kg

NEW

INCLUDED STANDARD ACCESSORIES

Smoke-gray filter (378-0581-00); camera gasket and mounting screws (016-0114-00); power cord (161-0036-00); 3 to 2-wire adapter (103-0013-00); 2 instruction manuals each: 521/R521 070-1027-00, 522/R522 070-1033-00.

TYPES R521 and R522: Same as Types 521 and 522 but include rackmounting hardware, and mounting tracks (351-0101-00).

ORDERING INFORMATION

Cabinet Model PAL Vectorscopes

TYPE 521 ..... **$2150**
TYPE 522 ..... **$2400**

Rackmount Model PAL Vectorscopes

TYPE R521 ..... **$2175**
TYPE R522 ..... **$2425**

UHF connectors are optional and may be specified without additional cost.

OPTIONAL ACCESSORIES

C-27 TRACE RECORDING CAMERA

f/1.9, 1:0.5 lens; Polaroid Land* Pack-Film back.
Order C-27-549 ..... $505
Type 521/522 to C-27 Camera Adapter,
order 016-0225-02 ..... $ 16

*Registered Trademark, Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon

75-Ω VOLTAGE STEP-UP TERMINATION

The 75-Ω Voltage Step-Up Termination provides a ×5 increase in chrominance amplitude and permits Differential Gain and Differential Phase measurements to be made to a higher degree of accuracy when used with a Tektronix Vectorscope. Input impedance to the termination is a constant 75 Ω. Use of the termination requires a source of external sync to the vectorscope.

FOR USE WITH TYPE 521 VECTORSCOPE
BNC connectors, order 011-0109-00 ..... $27.50

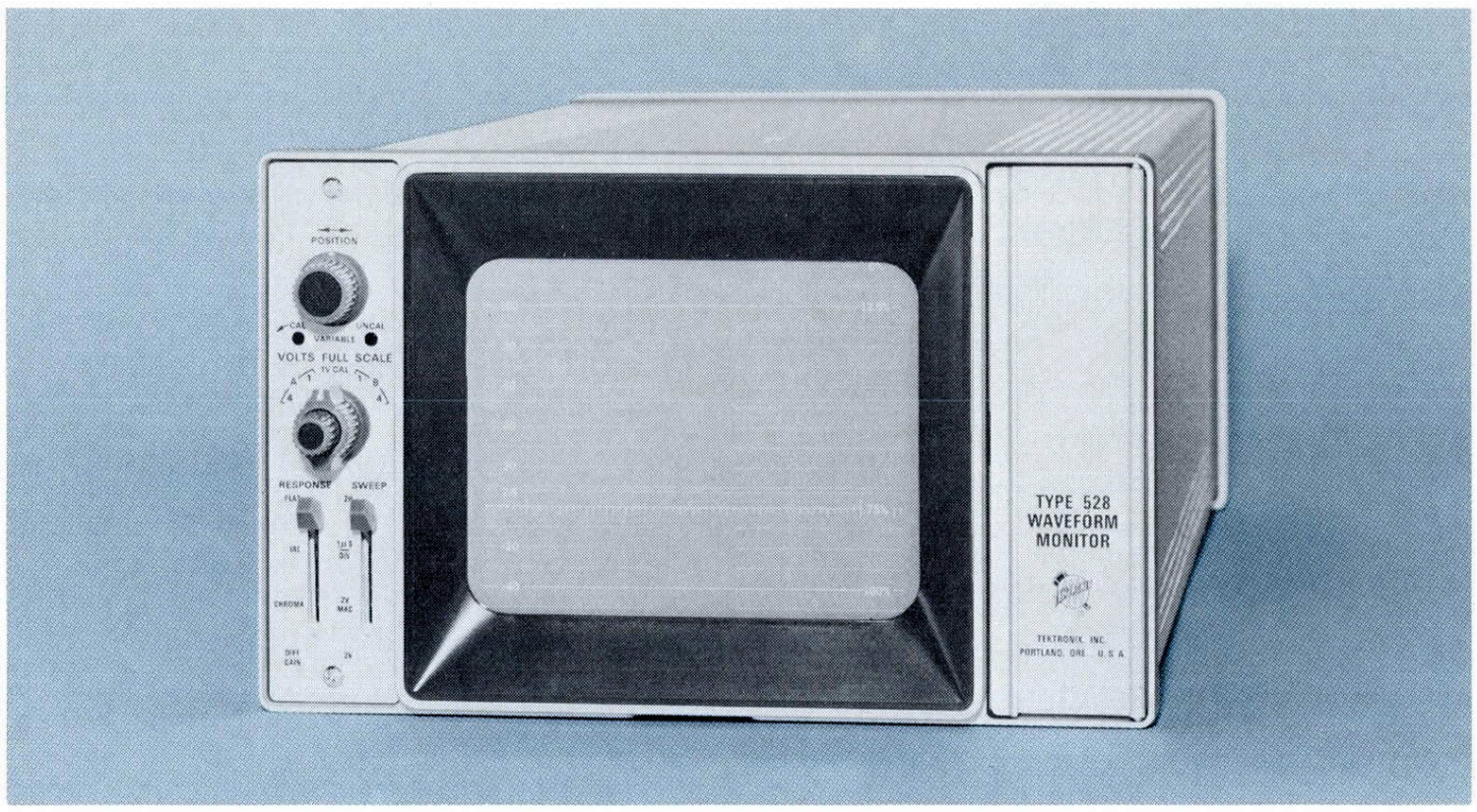
FOR USE WITH TYPE 522 VECTORSCOPE
UHF connectors, order 011-0100-00 ..... $27.50
BNC connector, order 011-0100-01 ..... $27.50

SINGLE SIDEBAND CHROMA AMPLITUDE EQUALIZER

The Single Sideband Chroma Amplitude Equalizer is designed for use with a Tektronix Vectorscope in transmitter applications where a vestigial sideband signal is being demodulated with a detecting diode. The corrector provides a ×2 increase in chrominance amplitude and passes luminance components with little or no attenuation. Input impedance is 75 Ω.

FOR USE WITH TYPE 521 VECTORSCOPE
UHF connectors, order 011-0108-00 ..... $27.50
BNC connectors, order 011-0108-01 ..... $27.50

FOR USE WITH TYPE 522 VECTORSCOPE
UHF connectors, order 011-0107-00 ..... $27.50
BNC connectors, order 011-0107-01 ..... $27.50



- ***LARGE 8 x 10-cm DISPLAY AREA***
- ***1/2 RACK SIZE***
- ***TWO VIDEO INPUTS***
- ***PICTURE MONITOR OUTPUT***
- ***SELECTABLE 1-VOLT AND 4-VOLT FULL SCALE DEFLECTION FACTORS***
- ***YRGB AND RGB INPUTS***
- ***ALL SOLID-STATE—LOW POWER CONSUMPTION***

The solid-state Type 528 Television Waveform Monitor provides bright, easy-to-read video waveform displays on a 5-inch CRT, yet requires only 5-¼-inch vertical height and ½-rack width mounting space. This compact instrument is especially well suited for monitoring signals from camera outputs, video system output lines, transmitter video input lines, closed-circuit TV systems and educational TV systems.

Either of two video inputs, selectable from the front panel, may be displayed. The displayed video signal is also provided at a video output jack for viewing on a picture monitor. Calibrated, 1-volt and 4-volt full scale (140 IRE unit) sensitivities are provided for displaying common video and sync signal levels. A variable sensitivity control permits uncalibrated displays from 0.25-volt to 4.0-volt full scale. The built-in 1-volt calibration signal may be switched on to check vertical sensitivity calibration. Flat, IRE, Chroma, and Diff Gain frequency response positions permit observation of various signal characteristics.

Horizontal Sweep selection provides 2 H (two line), 1 μs/div (expanded two line), 2 V (two field) and 2 V MAG (expanded two field). Displays of RGB and YRGB waveforms from color processing amplifiers are provided for with interconnection through a rear-panel 9-pin receptacle.

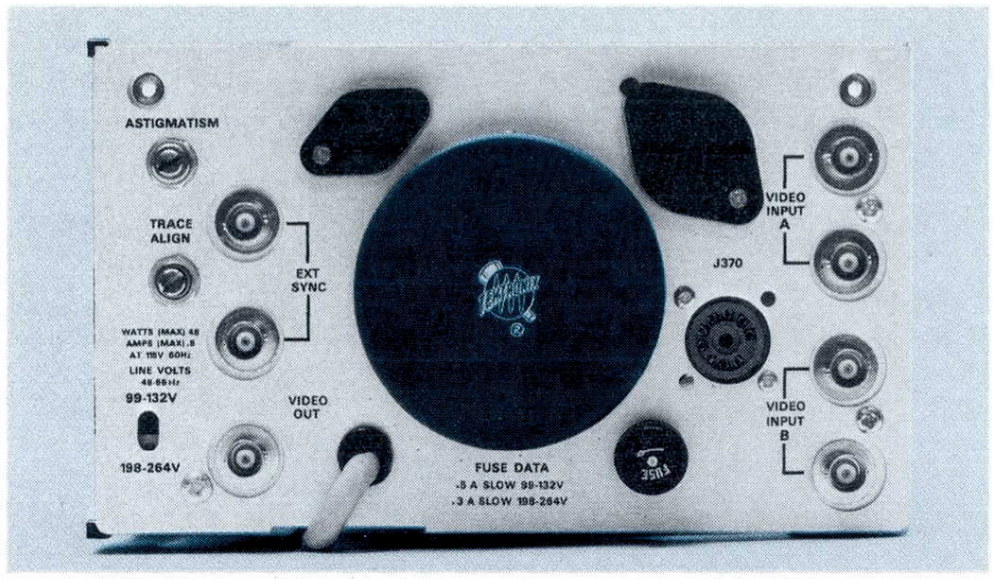
A DC Restorer maintains the back porch at an essentially constant level despite changes in signal amplitude, APL and color burst. May be turned off when not needed.

All solid-state circuitry provides low power consumption, and long-term reliability.

VIDEO FEATURES

INPUTS

Rear-panel BNC connectors provide two unbalanced inputs (A & B) which may be used with either 75-Ω loop-through or bridging connection. Maximum return loss for A and B video inputs, terminated in 75 Ω, operating or non-operating is 46 dB or greater to 5 MHz. Normally AC coupled but may be easily modified by user for DC coupling.



Rear panel of Type 528 Waveform Monitor.

DEFLECTION FACTOR

Calibrated 1-volt and 4-volt (for 140 IRE unit deflection) positions are provided for video inputs A or B with accuracy within 1% for the 1-volt positions and 3% for the 4-volt positions. A variable sensitivity control permits uncalibrated displays from 0.25-volt to 4.0-volt full scale.

FREQUENCY RESPONSE

4 response positions are provided: FLAT—25 Hz to 3.6 MHz within 1% of response at 50 kHz, 3.6 MHz to 5 MHz +1%, —3% of response at 50 kHz, and +1%, —3% of response at 3.58 MHz; IRE—per 1958 IRE STD 23S-1 (amended). Response at 4.43 MHz attenuated at least 22 dB; CHROMA—30% down between 3.1 MHz and 3.4 MHz, 30% down between 3.8 MHz and 4.1 MHz. Response at 3.58 MHz does not vary between FLAT and CHROMA by more than 1%. DIFF GAIN—same as CHROMA response with additional gain for displaying 100 IRE units of 90 mV to 143 mV subcarrier levels.

DIFFERENTIAL GAIN

1% or less with 10 to 90% APL changes using DIFF GAIN operating mode with modulated staircase signal, baseline adjusted to 50 IRE units position, and signal adjusted to 100 IRE units P-P.

TRANSIENT RESPONSE

1-volt or 4-volt calibrated deflection factor, FLAT response position, using 125-ns HAD $\sin^2$ pulse and bar test signal: preshoot is not more than 1 IRE unit, overshoot not more than 2 IRE units, ringing not more than 2 IRE units and pulse to bar ratio within 0.99:1 to 1.01:1.

LOW FREQUENCY TILT

% or less tilt on the vertical window or 60 Hz squarewave (DC Restorer off).

MAXIMUM INPUT LEVEL

MAXIMUM DC INPUT

5 volts‡ for all response positions using AC coupling.

MAXIMUM AC INPUT

Flat and IRE response—Signal levels should be limited to produce displays not exceeding 200 IRE units.

CHROMA response—Chroma levels up to 140 IRE units may be displayed, provided the chroma plus luminance level does not exceed 200 IRE units when viewed in the FLAT response mode.

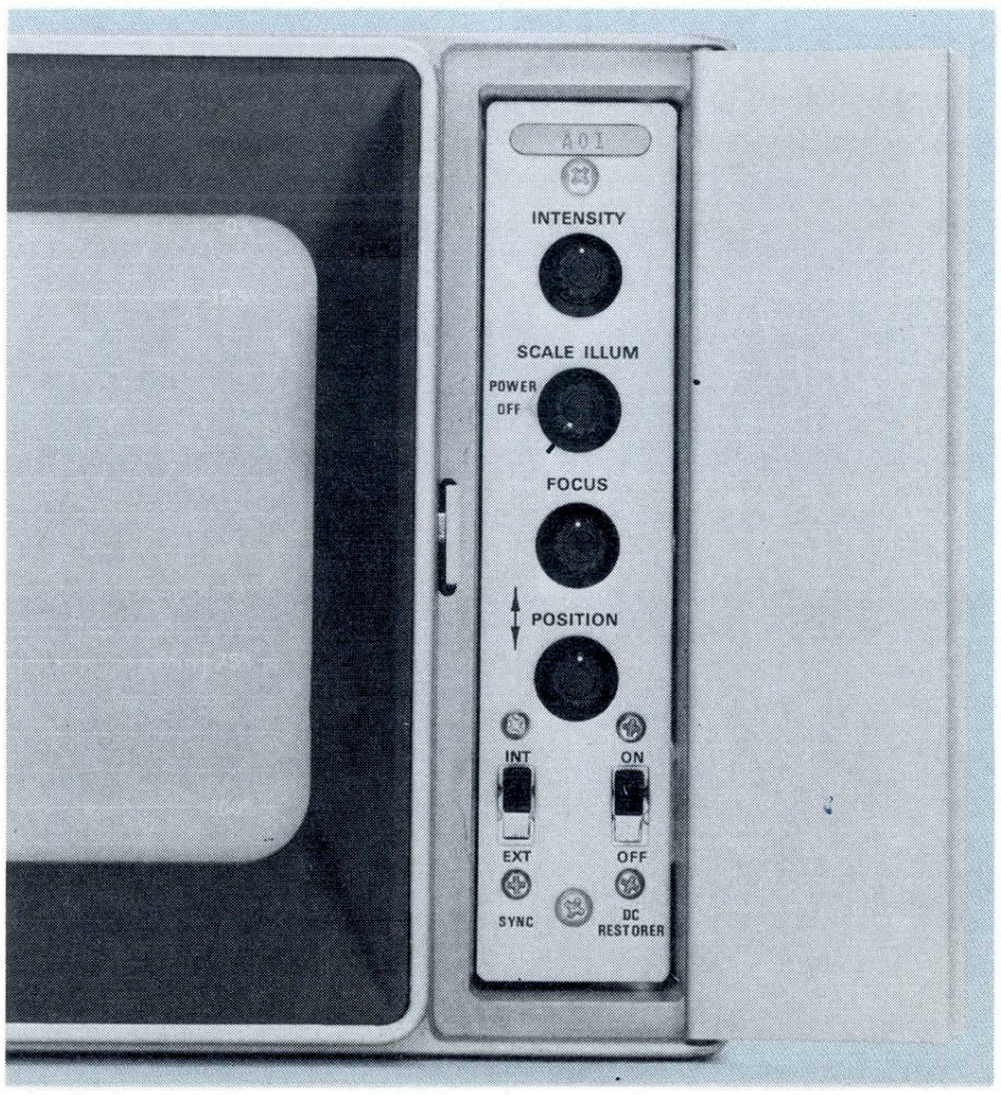
DIFF GAIN—Subcarrier signal levels of 90 mV to 143 mV peak to peak may be expanded, using the variable gain control, to 100 IRE units for measurement of differential gain with 10 to 90% APL.

DC RESTORER

Slow acting back porch DC restoration. Blanking level shift due to presence or absence of burst or changes in APL from 10% to 90% will not exceed 2 IRE units. May be disabled when desired.

VIDEO OUTPUT

The displayed signal is provided at a rear-panel BNC connector. Frequency response is 25 Hz to 5 MHz within 3%. Output signal amplitude is 1 volt within 15% for 140 IRE unit display using the FLAT response mode. DC level is 2 volts‡ or less into 75-Ω load. Nominal output impedance is 75 Ω. Return loss is 30 dB† or greater from 25 Hz to 5 MHz.



Infrequently used operating controls are conveniently located behind a front-panel hinged door.

†Exceeds CCIR recommendation 451-2 paragraph 3.1.

‡Exceeds CCIR recommendation 451-2 paragraph 3.2.

TIME BASE FEATURES

SYNCHRONIZATION

Internal or external sync is provided and is selectable by a switch behind the front panel hinged door. Internal sync is derived from composite video input. External sync is via a rear panel BNC loop-through connector and requires 1.5-volts to 4.5-volts composite sync input. The unterminated sync input impedance is approximately 15 kΩ paralleled by approximately 5 pF and maximum input voltage is 20 volts.‡

SWEEP MODES

4 sweep modes are provided: 2-V SWEEP—repetition rate equal to frame rate of applied video or external sync; 2-V MAG SWEEP—expands the vertical blanking interval (approximately 20X magnification of 2 V); 2-H SWEEP—repetition rate equal to half-line rate of applied video or external sync; 1-μs/div SWEEP—calibrated sweep with accuracy within 3% for center 10 div of 12-div sweep, and linearity within 3% throughout horizontal POSITION range, excluding first and last div.

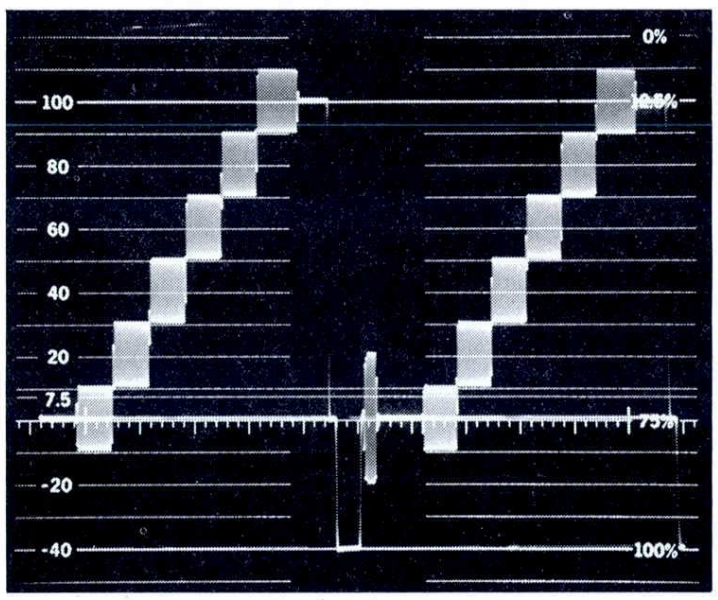


Fig 1. Modulated staircase signal. 2 H SWEEP, FLAT response.

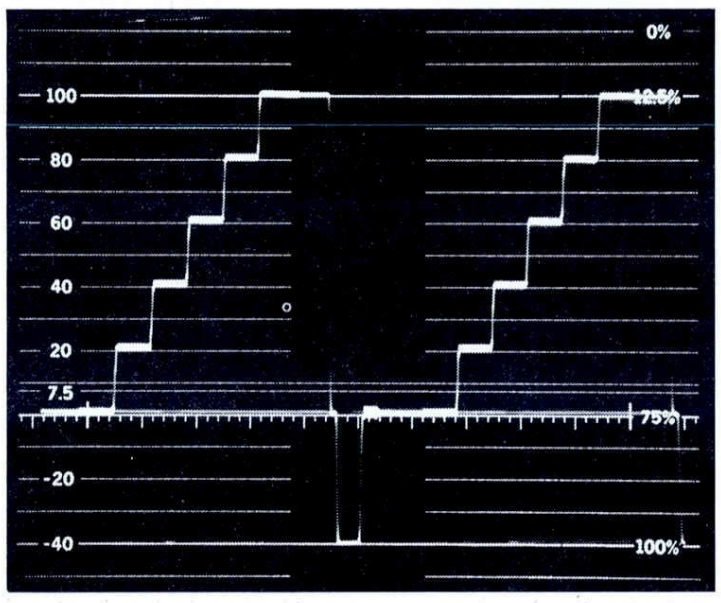


Fig 2. Modulated staircase signal. 2 H SWEEP, IRE response.

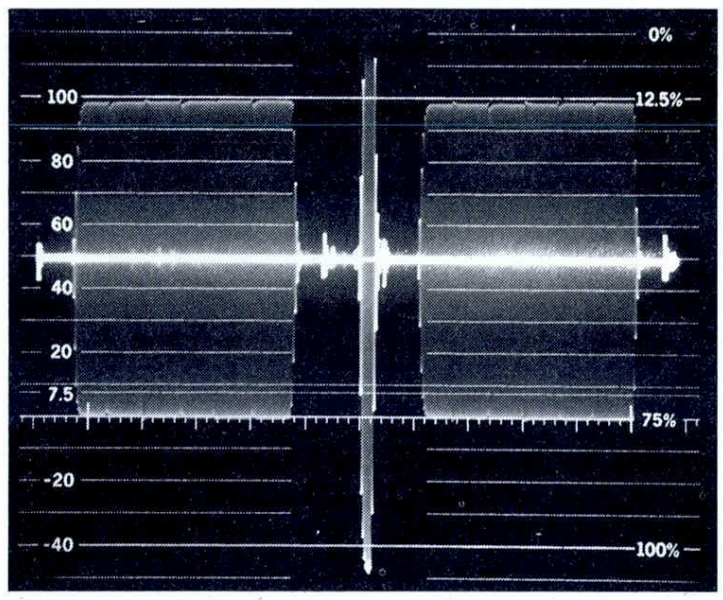


Fig 3. Modulated staircase signal. 2 H SWEEP, DIFF GAIN response.

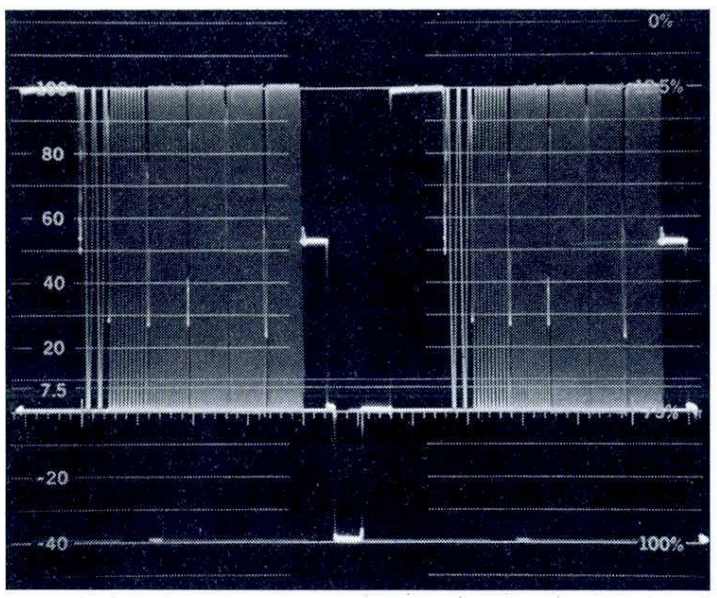


Fig 4. Multiburst signal. 2-H SWEEP, FLAT response.

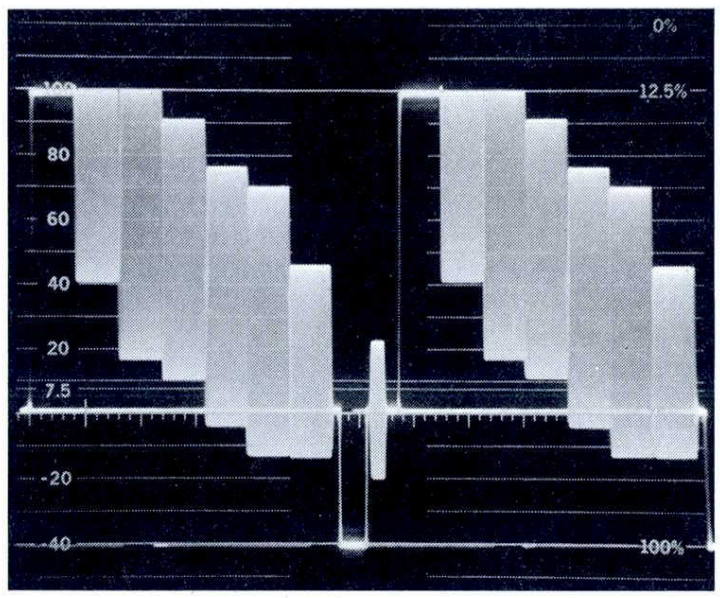


Fig 5. 75% saturated color bar signal. 2-H SWEEP, FLAT response.

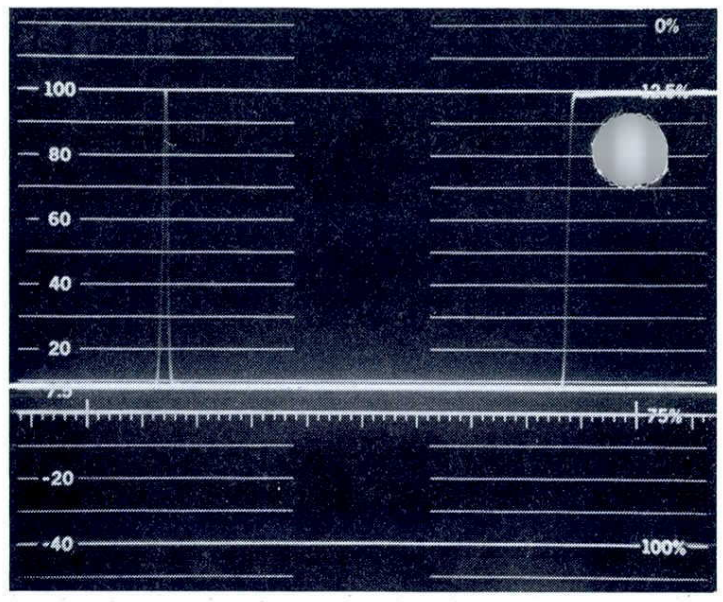


Fig. 6. .125 μs HAD Sin² Pulse and Bar. 1-μs/div calibrated sweep, FLAT response.

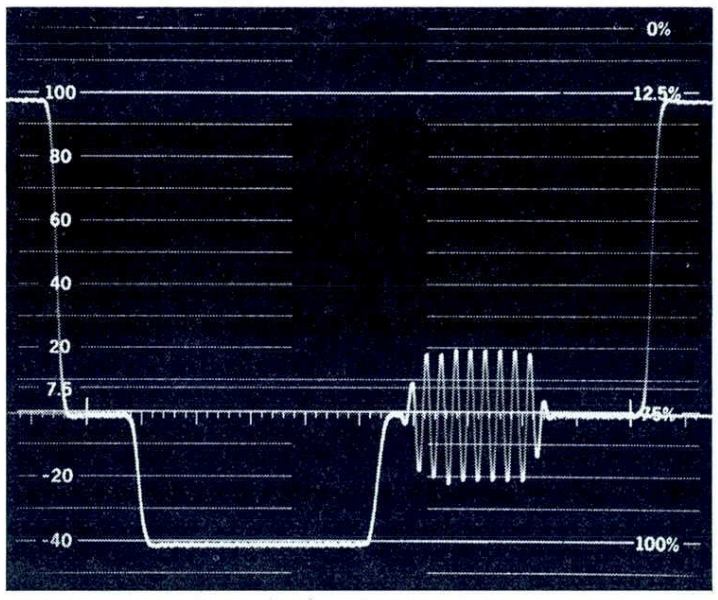


Fig. 7. Horizontal Blanking Interval. 1-μs/div calibrated sweep.

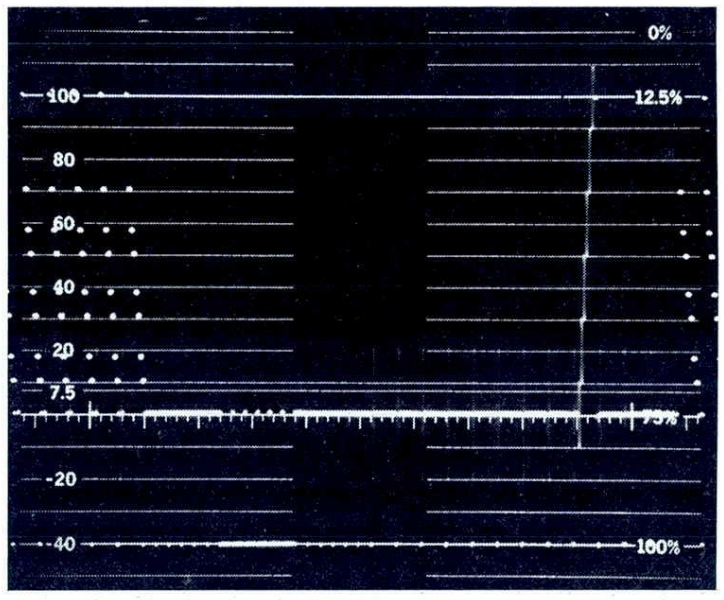


Fig 8. Vertical Blanking Interval. 2-V MAG SWEEP. 20X magnification permits convenient vertical blanking interval observation.

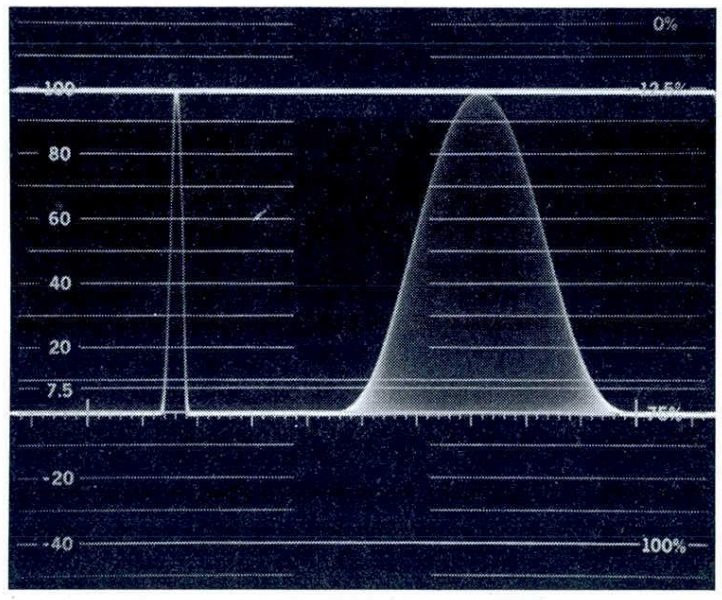


Fig 9. .250 μs HAD Sin² Pulse (left) and Modulated 20 T Sin² Pulse (right) with superimposed Bar Signal (top).

‡Exceeds CCIR recommendation 451-2, paragraph 3.2

YRGB AND RGB DISPLAYS

The Type 528 can be used with color camera processing amplifiers which provide the necessary sequential signal switching and staircase signals. A rear panel 9-pin receptacle provides the necessary interconnections. Factory wired for RGB (3 step) input.

STAIRSTEP AMPLITUDE

A 10-volt amplitude stairstep signal will produce a 9-div display length within 15%.

STAIRSTEP DC LEVEL

Peak AC plus DC signal levels shall not exceed limits of −12 to +12 volts. Maximum AC signal level is 12-volts peak-to-peak.

CONTROL SIGNALS

The RGB or YRGB modes may be initiated through the use of external voltage (12 volts to 15 volts) or ground connection at the rear panel 9-pin receptacle. A 9-pin plug is supplied with the included standard accessories.

OTHER FEATURES

REGULATED POWER SUPPLY

Operates on 99 volts AC to 132 volts AC and 198 volts AC to 264 volts AC, 48 Hz to 66 Hz line frequency. Operates on 115 volts ±10% or 230 volts ±10% at line frequencies from 66 Hz to 440 Hz. POWER CONSUMPTION: approx 48 watts at 115 volts AC, 60 Hz.

TEKTRONIX CATHODE-RAY TUBE

A flat-faced 5-inch rectangular CRT providing an 8 x 10-cm display area. P31 phosphor supplied. External graticule with variable illumination.

CALIBRATOR

An internal calibration signal provides a convenient reference for verifying deflection factor. Amplitude is 1.0 volt within 1%.

DIMENSIONS AND WEIGHTS

Type 528:	Height	5¼ in	13.3 cm
	Width	8½ in	21.6 cm
	Depth	18½ in	47.0 cm
	Net weight	15 lb	6.8 kg

INCLUDED STANDARD ACCESSORIES

9-pin connector (136-0099-00), connector cover (200-0249-00), two instruction manuals (070-0800-00).

ORDERING INFORMATION

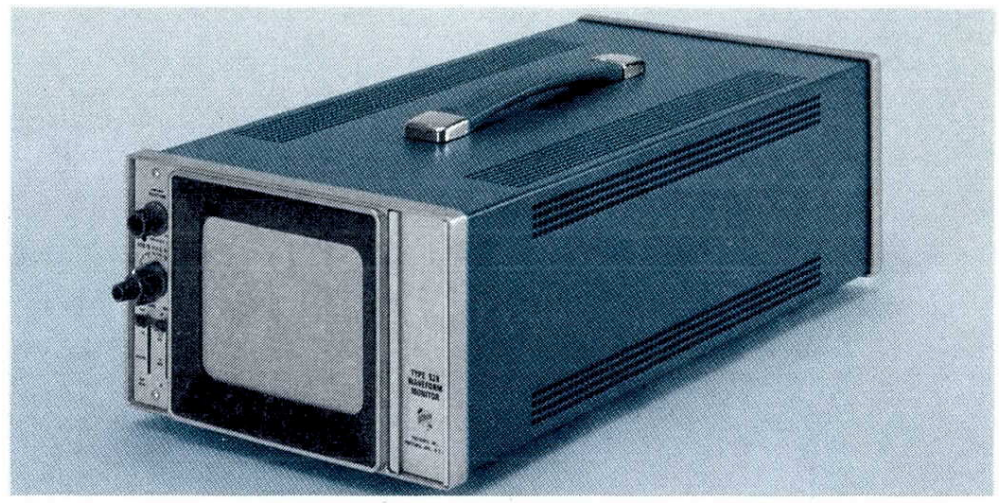
ORDER TYPE 528 FOR 525-LINE, 30-FRAME TELEVISION STANDARDS

TYPE 528 WAVEFORM MONITOR $890

TYPE 528 MOD 146B WAVEFORM MONITOR $865
As above, but less cover, for mounting in Tektronix rack adapter (016-0115-02).

ORDER TYPE 528 MOD 188G FOR 625-LINE, 25-FRAME TELEVISION STANDARDS, CALIBRATED WITH CCIR SIGNALS WITH CHROMA RESPONSE CENTERED AT 4.43 MHz.

TYPE 528 MOD 188G WAVEFORM MONITOR $890

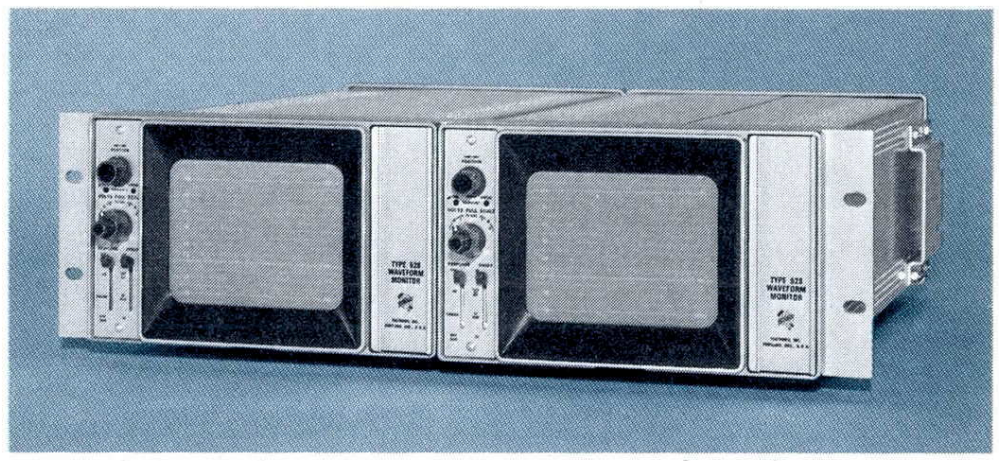


TYPE 528 WITH PROTECTIVE CABINET

The Type 528 MOD 147B is a standard Type 528 provided with a protective cabinet for table-top use or portable applications. Cabinet is aluminum construction, blue vinyl finish.

TYPE 528 MOD 147B WAVEFORM MONITOR $920

OPTIONAL ACCESSORIES

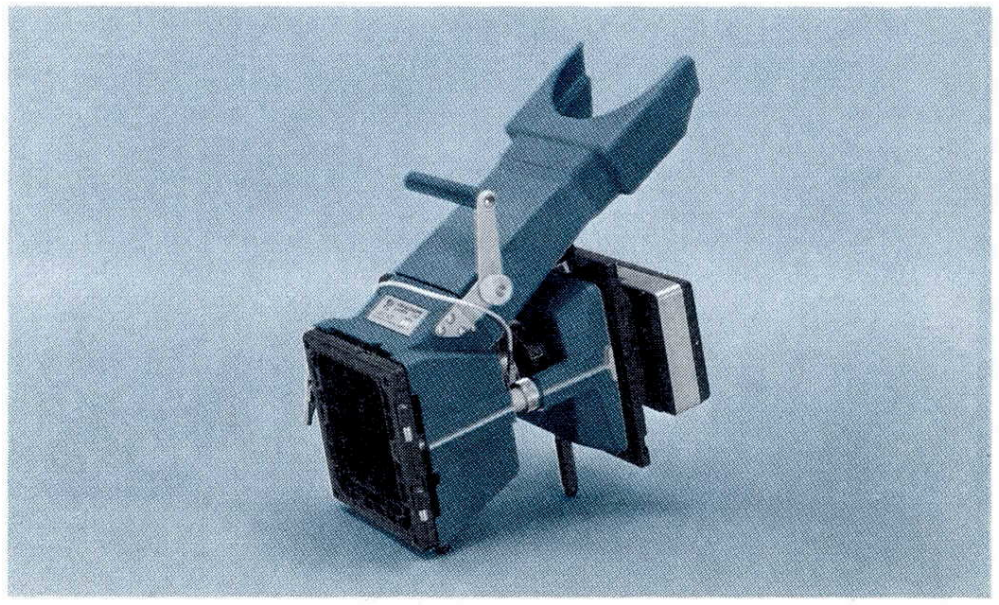


RACK ADAPTER

For mounting two Type 528's side-by-side in a standard 19-inch rack, order 016-0115-02 . . . . . $ 95.00

PANEL ASSEMBLY

For covering ½ of rack adapter when only one Type 528 is rackmounted, order 016-0116-00 . . . . . $ 8.00



C-27 CAMERA

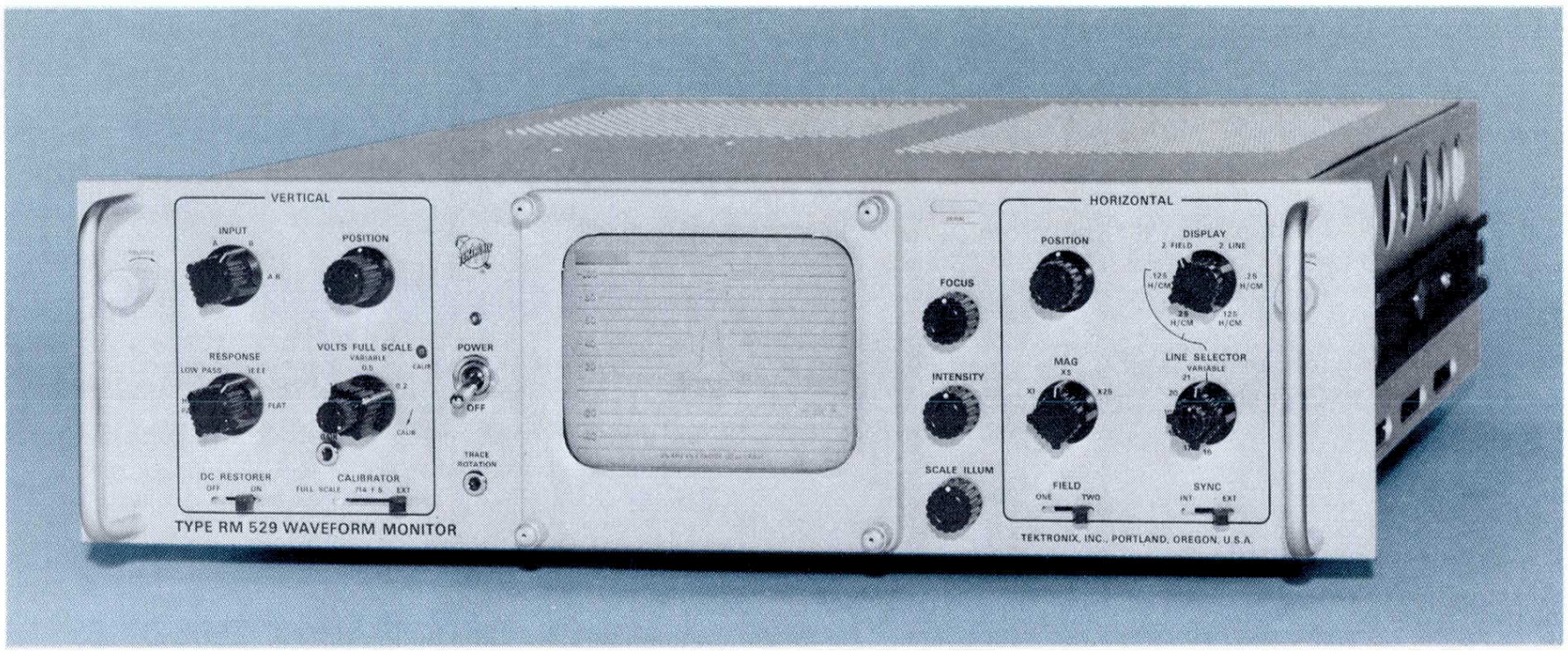
f/1.9, 1:85 lens, Polaroid Land* Pack-Film back, order C-27 . . . . . $460.00

Type 528 to C-27 camera adapter, 016-0249-01 . . . . . $ 16.00

*Registered Trademark Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

529 Television Waveform Monitor R529



- ***LINE SELECTOR***
- ***FLAT TO 8 MHz***
- ***4 FREQUENCY RESPONSES***
- ***POSITIVE FIELD SELECTOR***
- ***COOL—QUIET—CLEAN***
- ***NO FAN—ONLY 80 WATTS***
- ***AVAILABLE FOR USE WITH SEVERAL TV STANDARDS***

The Type 529 and RM529 bring to the Industry a new flexibility in waveform monitoring: signal-level monitoring, bandwidth and differential gain measurements, sine^2-pulse and bar testing, monitoring Vertical Interval Test signals, transmitter percent-of-modulation measurements, YRGB displays (in conjunction with color-processing amplifiers) and others. Included are four video response characteristics, HIGH-PASS, LOW-PASS, IEEE, and FLAT. Both instruments feature FLAT RESPONSE to 8 MHz, assuring excellent waveform fidelity for sine squared testing with 2T, T and $\frac{1}{2}$T pulses.

DC RESTORATION maintains the back porch at an essentially constant level despite changes in signal amplitude, APL, and color burst, and may be turned off for viewing other than video signals. The circuit can easily be modified for sync-tip restoration.

Sensitivity range is 0.12 volts to 1.5 volts for full-scale deflection. Full-scale calibration at 0.714 V or 1.00 V is provided.

BRIGHT WAVEFORM DISPLAYS in line selector operation are obtained with a highly-efficient 5-inch aluminized CRT. The instrument uses the best of both solid-state and vacuum-tube circuitry resulting in improved stability and reliability. These instruments do not require a fan, resulting in cleaner operation and complete freedom from noise.

HORIZONTAL SELECTION provides 2-field or 2-line displays, plus calibrated sweep rates of 0.125 H/cm or 0.25 H/cm. Either calibrated rate may be delayed for line selection. SWEEP MAGNIFICATION extends the sweep rate by X5 or X25, offering calibrated sweep rates from 0.250 H/cm to 0.005 H/cm. POSITIVE FIELD SELECTION assures stable displays in the presence of random noise bursts and video switching. The LINE SELECTOR permits detailed study of any portion of any desired line(s), and a front panel switch selects lines 16 through 21 for viewing VIT signals. A VIDEO-OUTPUT AMPLIFIER supplies video and a brightening pulse to the associated picture monitor, intensifying the same line, or lines, displayed on the instrument when using the LINE SELECTOR.

529 Television Waveform Monitor R529

VIDEO FEATURES

INPUTS
Two unbalanced inputs through rear-panel BNC connectors may be used with either 75-Ω loop-through or bridging connection (input R & C is 1 MΩ and 24 pF). Return loss is greater than 46 dB to 5 MHz using 75-Ω loop-through. Alternatively, one balanced, differential input may be used.

DEFLECTION FACTOR
120 mV to 1.5 V full scale. Continuously variable between ranges. Calibrated full-scale: 1.0, 0.50 and 0.20 V.

FREQUENCY RESPONSE
4 response characteristics provide: FLAT: +0.0 — 1% to 6 MHz; +0.0 — 3% to 8 MHz. IEEE: IRE-Spec 23S-1 of 1958 (amended): HIGHPASS: 3.58 MHz plus and minus 400 kHz at 15% to 35% down. LOW PASS: At least 80% down at 500 kHz.

LOW FREQUENCY TRANSIENT RESPONSE
≤3% tilt of window display (tilt is expressed as a percentage of P-P display).

DC RESTORER
Keyed back porch* type eliminates drift in DC-coupled vertical amplifier. Does not distort color burst. Waveform will remain on screen if there is a loss of sync pulses for DC restorer keying. DC restorer may be disabled by front-panel switch.

VERTICAL AMPLIFIER
May be DC-coupled to diode demodulator as in % Video Modulation Monitoring. Details are available in manual.

VIDEO OUTPUT
Signal is provided for driving a picture or line monitor with amplitude into 75 ohms approx equal to input signal to 529/RM529.

TIME-BASE FEATURES

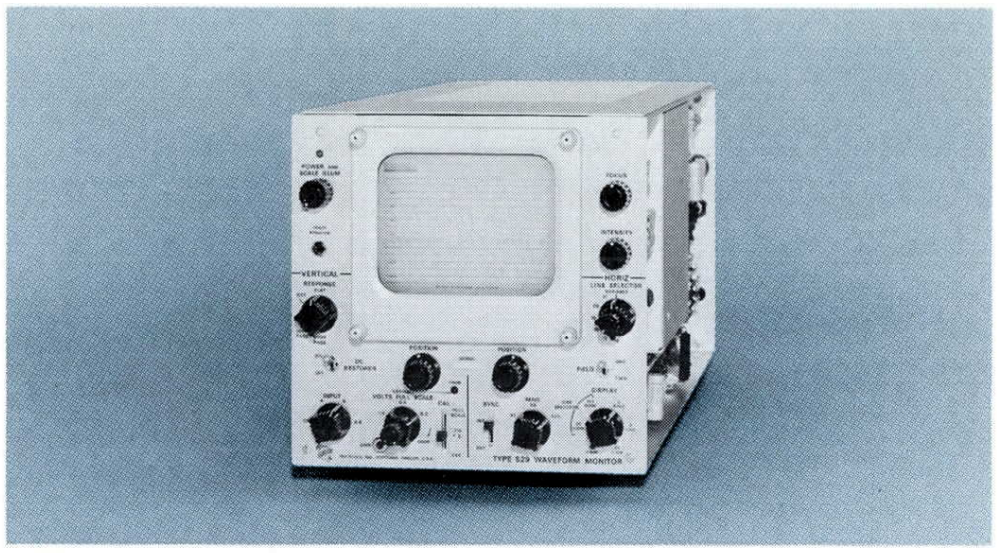
CALIBRATED TIME BASE
0.125 H/cm. Magnifier extends calibrated time base to 0.025 H/cm and 0.005 H/cm. Accuracy is ±3%. Rep rate is ½ of the TV line rate. The time base can be calibrated using TV signals. Color burst is displayed without phase interlace.

UNCALIBRATED TIME BASE
2 LINE: Triggered time base with rep rate of ⅓ TV line frequency. Provides complete 2-line display with horizontal blanking centered on the screen.

2 FIELD: Synchronized time base with rep rate the same as the TV frame rate. Entire frame of video is displayed with the vertical blanking centered on the screen. Time base will free-run in the absence of signal, indicating loss of incoming signal.

TIME-BASE MAGNIFIER
X5 and X25. Accuracy ±3%. Magnifier expands the center of the display, convenient for monitoring equalizing or serrated pulses.

*Sync tip restoration available by simple modification.



COLOR CAMERA YRGB DISPLAYS
Can be used with color camera processing amplifiers providing these sequential signals and the staircase signal. To provide YRGB display directly, switching is done in the color processing amplifier. Receptacle to interconnect color processing amplifier (relay control, staircase signal input, and ground) is provided on rear panel.

VIT SELECTOR
Front-panel switch selects lines 16 through 21. Knob position indicates line selected for viewing.

LINE SELECTOR
Variable delay allows any line of either field to be viewed.

FIELD SELECTOR
Positive-acting field selection.

TRIGGER SELECTION
Stable triggering on composite video signals. INTERNAL: 200 mV to 1 V or more, peak to peak. EXTERNAL: 250 mV to 1 V or more, peak to peak.

OTHER FEATURES

REGULATED POWER SUPPLY
Operates on 115 V or 230 V line ± 10% RMS. LINE FREQUENCY: 50-60 Hz. POWER CONSUMPTION: Approx 80 W at 115 V, 60 Hz.

TEKTRONIX CATHODE-RAY TUBE
Flat-faced, 5-inch rectangular CRT, operating at 6.4 kV accelerating potential. Calibrated viewing area, 7 x 10 cm. Electrical beam rotator provides trace alignment. P31 phosphor is normally supplied. External graticule, variable illumination.

CALIBRATOR
Two internal calibration voltages of 0.714 V and 1.00 V on 1-volt full-scale range of VERTICAL GAIN switch. An external calibration signal may be used. Internal calibration pulse amplitude ±1% over ambient temperature range and line-voltage range. Reference is a Zener diode.

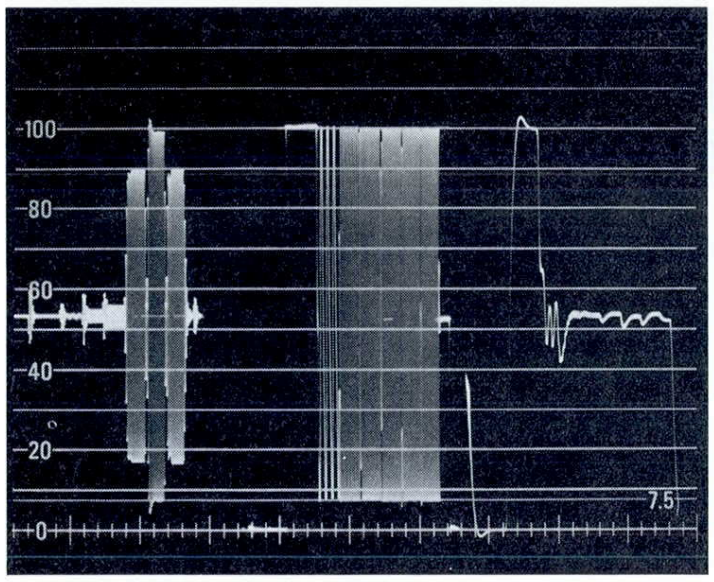
VENTILATION
Convection air-cooled. Operating Temperature Range: 0° C to +50° C.

DIMENSIONS AND WEIGHTS

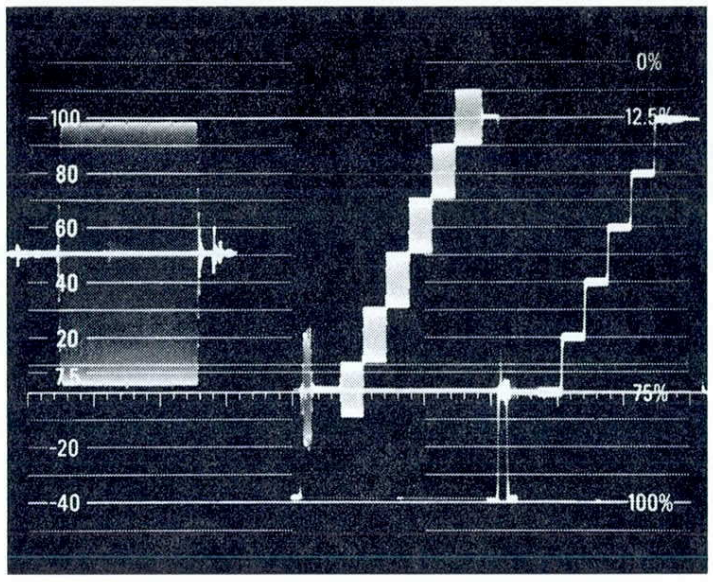
TYPE 529:	Height	8¼ in	21 cm
	Width	8½ in	21.6 cm
	Depth	19½ in	49.7 cm
	Net weight	27 lb	12.2 kg
	Domestic shipping weight	≈34 lb	≈15.5 kg
	Export-packed weight	≈47 lb	≈21.4 kg

Two Type 529 Waveform Monitors can be mounted side-by-side, or one mounted alongside an associated picture monitor in a standard 19-inch rack or console.

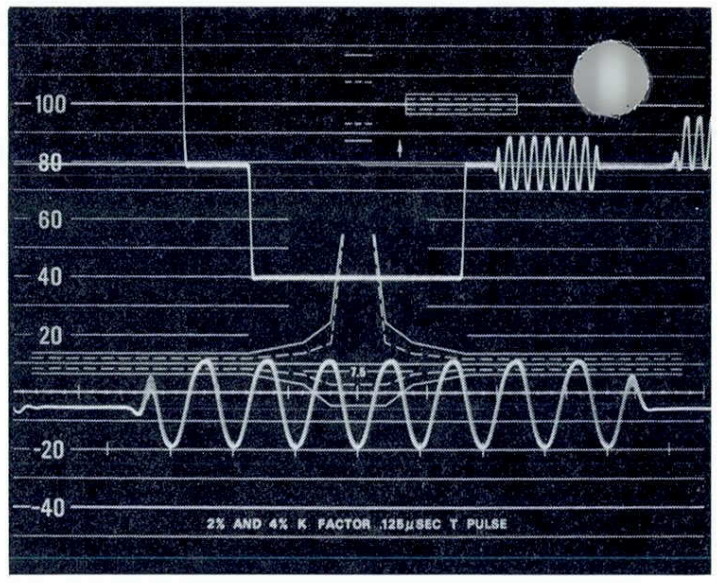
529 Television Waveform Monitor R529



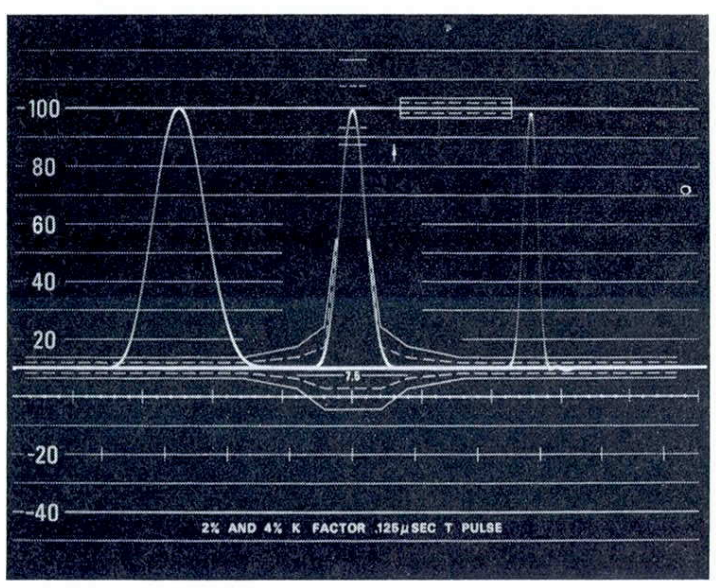
Multiburst Signal. Multiple exposure showing High-pass, Flat, and Low-pass response.



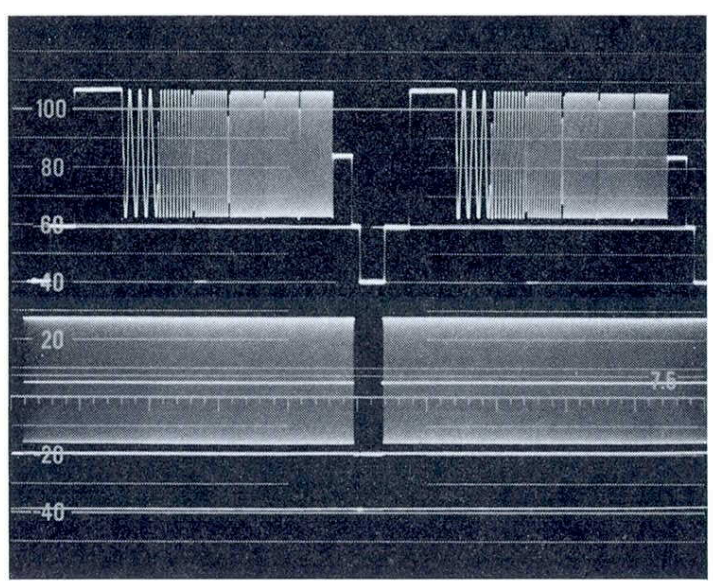
Modulated Staircase Signal. Multiple exposure left to right. High-pass position for measuring differential gain, Flat-response position, IEEE response position.



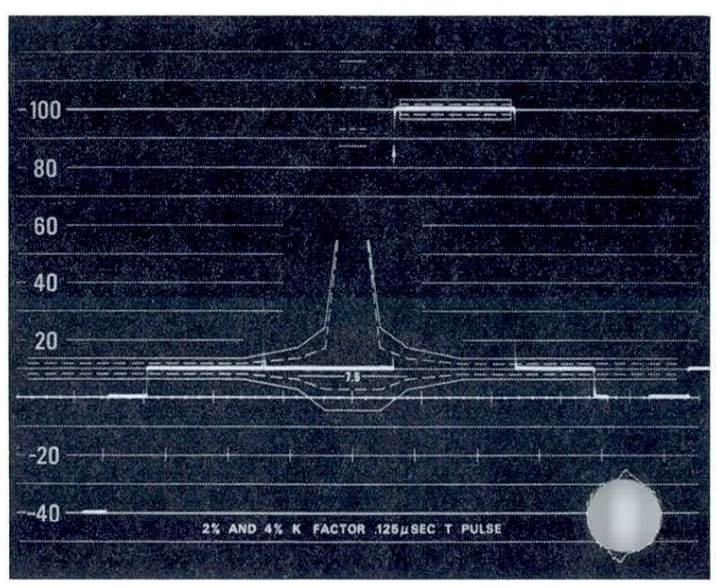
Color-Burst Signal. Double exposure. Top: X5 magnification. Horizontal display: 0.125 H/cm. Bottom: X25 magnification. Horizontal display: 0.125 H/cm.



Multiple exposure. Left: 2T. Center: T. Right: ½ T Sine², 0.25, 0.125, 0.0625 μs HAD.



Double exposure showing complete two-field displays and two-line displays.



Sine² Pulse and Bar Signal. 0.125 μs HAD T-Pulse and Bar.

TYPE RM529:	Height	5¼ in	13.3 cm
	Width	19 in	48.2 cm
	Rack depth	18¼ in	46.4 cm
	Net weight	30½ lb	13.9 kg
	Domestic shipping weight	≈59 lb	≈26.8 kg
	Export-packed weight	≈81 lb	≈36.8 kg

Instrument fits standard 19-inch rack, can be pulled forward and tilted 90°.

INCLUDED STANDARD ACCESSORIES

TYPE 529: Smoke-gray light filter (378-0560-00); composite graticule, shown lower center (331-0156-01); noncomposite graticule, shown top left (331-0077-01); dual scale graticule, shown top center (331-0157-00); sine², K factor, and IRE graticule, shown top right, lower left, lower right (331-0161-02); 75-ohm termination resistor (011-0102-00); 3 to 2-wire adapter (103-0013-00); two instruction manuals (070-0509-01); graticule light insert (377-0064-00). Type RM529: same as Type 529 but includes four retainer bars (381-0187-00); one pr tracks (351-0040-02); two instruction manuals (070-0466-01).

TYPE 529 WAVEFORM MONITOR $1200
TYPE RM529 WAVEFORM MONITOR $1250

TYPE 529 MOUNTING CRADLES

Two different cradle assemblies, with associated bezels, allow the Type 529 Waveform Monitor to be mounted alongside an 8-inch or 9-inch Conrac* Picture Monitor, in a standard 19-inch rack. A cradle and bezel are also available for mounting two Type 529's side-by-side.

*Registered Trademark, Conrac Corporation, Conrac Division

FOR MOUNTING 8-INCH CNB-8 PICTURE MONITOR (REQUIRES 10½-INCHES RACK SPACE)

Description	Part Number	Price
Cradle Assembly	014-0021-00	$35.00
Bezel, for mounting Type 529 on operator's left	014-0027-00	50.00
Bezel, for mounting Type 529 on operator's right	014-0028-00	50.00

FOR MOUNTING 8-INCH CZB-8 PICTURE MONITOR (REQUIRES 10½-INCHES RACK SPACE)

Cradle Assembly	014-0021-00	$35.00
Bezel, for mounting Type 529 on operator's left	014-0025-00	50.00
Bezel, for mounting Type 529 on operator's right	014-0026-00	50.00

FOR MOUNTING 9-INCH RNB-9 PICTURE MONITOR (REQUIRES 8¾-INCHES RACK SPACE)

Cradle Assembly	014-0020-00	$35.00
Bezel, for mounting Type 529 on operator's left	014-0023-00	40.00
Bezel, for mounting Type 529 on operator's right	014-0024-00	40.00

FOR MOUNTING TWO TYPE 529 WAVEFORM MONITORS SIDE-BY-SIDE (REQUIRES 8¾-INCHES RACK SPACE)

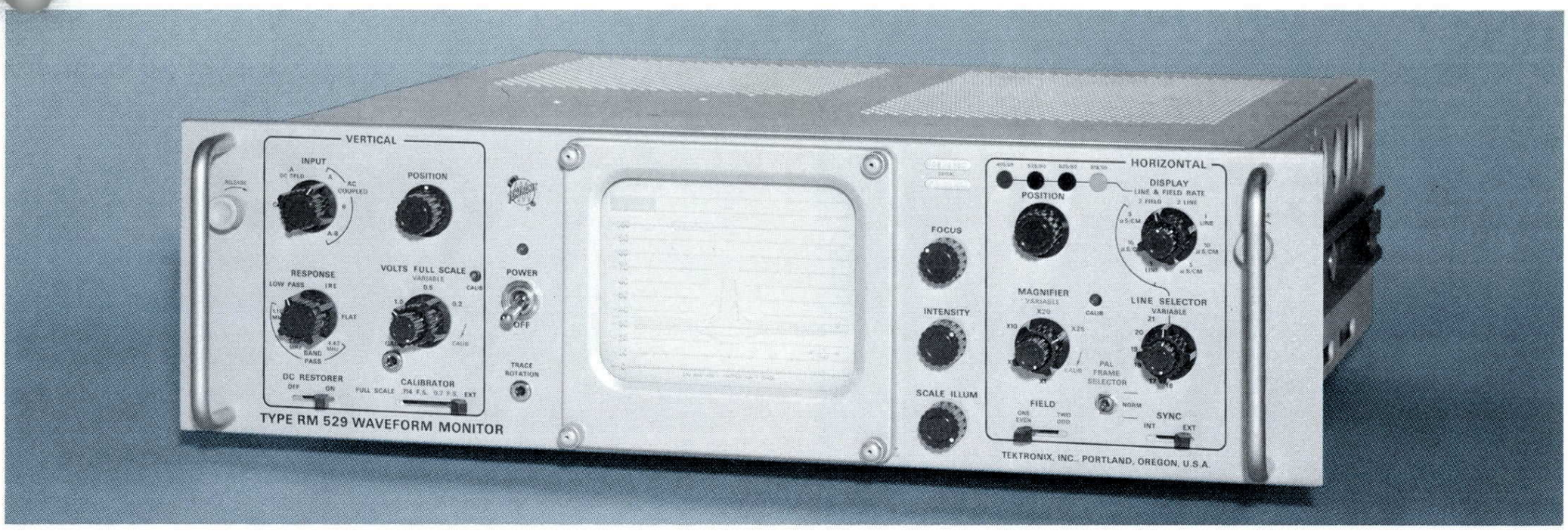
Cradle Assembly	014-0020-00	$35
Bezel	014-0022-00	40

RM529 CRADLE ASSEMBLY

For mounting the Type RM529 in a WECO backless rack, order 426-0309-00 . . . . . $ 9.50

529 Television Waveform Monitor R529

MULTI-STANDARD



Type 529 or RM529 MOD 188D

The Type 529 Mod 188D and Type RM529 Mod 188D Waveform Monitors are adapted for use with 405-line 50-Hz field rate, 525-line 60-Hz field, 625-line 50-Hz field, and 819-line 50-Hz field standard television systems. Added Vertical RESPONSE switch positions, added MAGNIFIER steps and VARIABLE control, 5 and 10 μs/cm sweep rates in addition to line and field rates, and a PAL FRAME SELECTOR permit quick setup for use on any of four systems without internal adjustments. Panel marking, color-coordinated with Line/Field indicator light colors, identifies control positions associated with the selected system.

The added PAL FRAME SELECTOR permits normal display from all frames or selection of either frame of the four-field PAL color system cycle.

The Vertical system features selectable DC coupling for Video Input A, and added 1.1 MHz and 4.43 MHz Bandpass positions of the RESPONSE switch. The CALIBRATOR switch has an added 0.70 F.S. position for proper calibration for systems based on a 30-unit (of 100) blanking level. Sweep rates based on line and field intervals are supplemented by fixed 5 μs/cm and 10 μs/cm rates. Extra X10 and X20 MAGNIFIER positions and a VARIABLE MAGNIFIER provide maximum flexibility of adjustment for various test signals.

VERTICAL SYSTEM:

Response Switch: Added positions of 1.1-MHz Bandpass (—18 dB at 0.2 MHz) and 4.43-MHz Bandpass (—3 dB bandwidth ≥800 kHz) at double sensitivity.

Calibrator: 0.70 F.S. position added for CCIR standards.

Input Switch: Added DC-coupled position for Input A.

HORIZONTAL SYSTEM:

Line/Field Rate Selection: 405/50, 525/60, 625/50, 819/50.

Sweep Rates: 2 Field, 2 Line, 1 Line, 5 μs/cm, and 10 μs/cm.

Line Selector Sweep Rates: 1 Line, 5 μs/cm, 10 μs/cm. Discrete line selection provided for 525/60 and 625/50 systems; for 405/50 and 819/50 systems, continuously-variable line selection only.

Accuracy: All sweep rates (except 2 Field, an uncalibrated rate) are accurate within 3% (MAG X1).

Magnifier: X1, X5, X10, X20, X25, plus VARIABLE (±20% from selected step).

Field Switch: Added Even/Odd marking for PAL standards. Positive field selection provided except for CCIR System E (change-of-field only).

Pal Frame Selector: 3-position switch for viewing all frames or selecting alternate frames.

GENERAL:

Line Voltage: +10%, —8% accommodation range at 105, 110, 115, 120, 210, 220, 230, or 240-V center voltage, 50 to 60 Hz. Normally wired and fused for 220 V. Multi-tap transformer can be changed for use with any of the listed nominal line voltages.

Accessories: The following graticules are furnished in addition to the standard 529/RM529 complement: 0-100 unit composite CCIR Video, 30-unit blanking level, PN 331-0184-00. 0-100 unit composite CCIR Video, with $\sin^2$ & K factor ruling for 0.1 μs T and 0.2 μs 2T pulses, 2% and 4% K factor, timing line for 4.43 MHz, PN 331-0185-00 (installed).

TYPE 529 MOD 188D **$1365**

TYPE RM529 MOD 188D (Rackmount) **$1405**

OPTIONAL ACCESSORIES

TYPE 529 FIELD CASE

Provides cabinet protection for the Type 529 when used for applications outside of the rack. Aluminum construction, blue vinyl finish; order 016-0084-00 ..... $35.00

C-27 CAMERA

f/1.9-1:0.85 lens; Polaroid Land* Pack-Film back, order C-27 ..... $460

Type 529 or RM529 to C-27 Camera Adapter, order 016-0224-00 ..... $ 16.00

*Registered Trademark, Polaroid Corporation

MESH FILTER

For improving display contrast when viewing under high-ambient light conditions; includes special graticule cover. Order 378-0575-00 ..... $16.00

9-PIN CONNECTOR

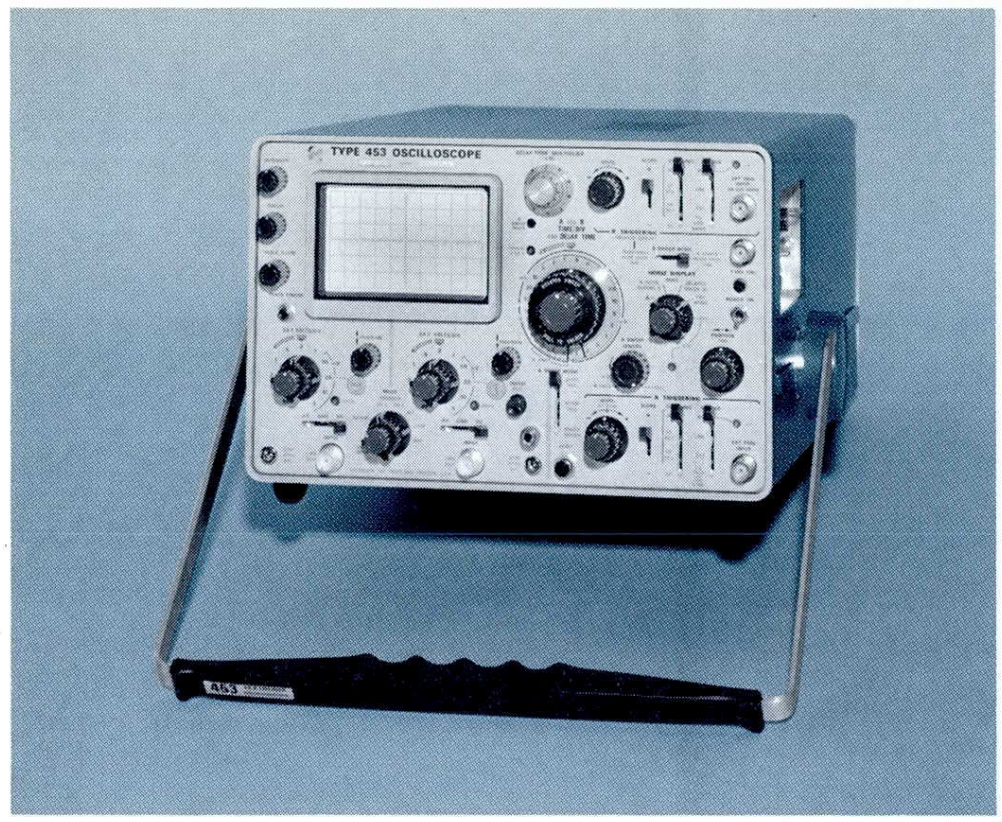
Used with color processing amplifiers for RBG, etc. displays. Order 134-0049-00 ..... $ 4.70

See the catalog accessory pages for additional information on other accessory items not listed.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Television Oscilloscope

TYPE 453 R453 MOD 127C



An internal TV Sync Separator circuit permits stable internal Line or Field-rate triggering from displayed composite video or composite sync waveforms. External ÷ 10 trigger sources are replaced by internal TV Sync positions providing Line (Horizontal) sync pulses to the B Sweep circuit and either Field (Vertical) or Line sync pulses to the A Sweep circuit.

Individual line selection of VIT (vertical interval test) signals is facilitated by the sweep delay features in the Type 453. The wide range of sweep delays permit accurate alternate-frame color-burst observations in the PAL color system.

Conventional waveform displays and measurements can be made from standard broadcast or closed-circuit TV systems, domestic or overseas, with up to 1201-line, 60-Hz field rates. Other characteristics are the same as Type 453 and R453. A parallax-free, 6 x 10 div, illuminated graticule is standard. Two additional snap-in TV graticules are supplied but may not be illuminated.

INCLUDED STANDARD ACCESSORIES

Same as Type 453 except as follows: delete two P6010 3.5-ft 10X probe packages (010-0188-00); add two P6010 6-ft probe packages (010-0185-00); two 6-32 adapters (103-0051-00); two spring phone tip adapters (206-0060-00); snap-in light filter/TV graticule (NTSC) 378-0576-04; snap-in light filter/TV graticule (CCIR) 378-0576-05.

TYPE 453 MOD 127C **$2135**

TYPE R453 MOD 127C **$2220**

TERMINATIONS

75-ohm termination. 75 ohms within 0.5% (at DC). Return loss is at least 52 dB, DC to 10 MHz, maximum input voltage is 5 V RMS, center conductor to ground.

BNC, order 011-0102-00 ..... $9.70

UHF, order 011-0104-00 ..... $9.70

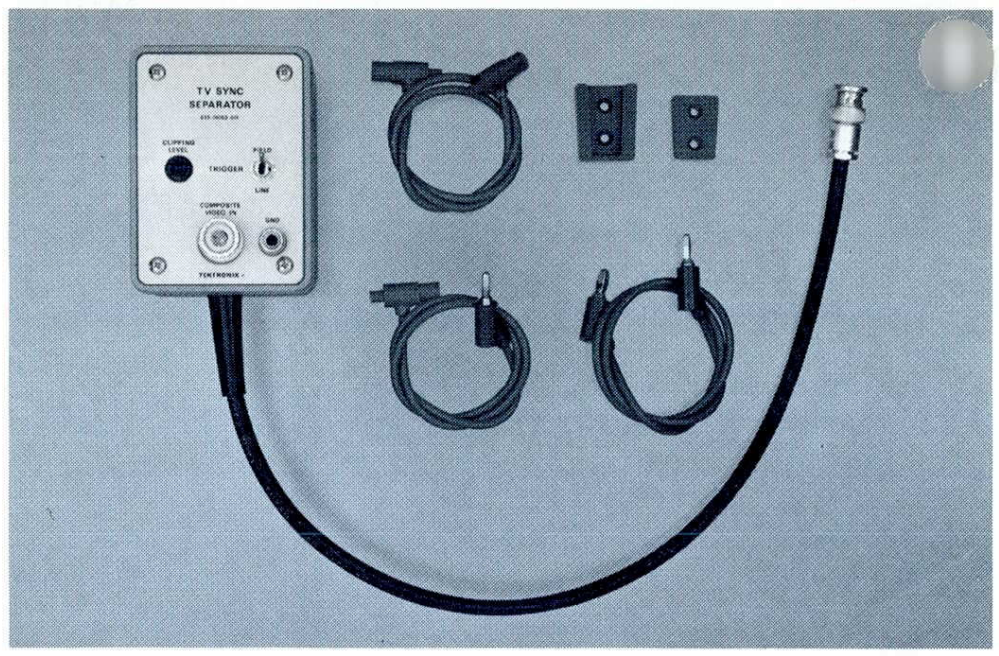
75 ohm feed through termination. 75 ohms within 0.2% (at DC). Return loss is at least 52 dB, DC to 10 MHz, maximum input voltage is 3 V RMS, center conductor to ground.

BNC, order 011-0103-02 ..... $9.70

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Television Accessories

TV SYNC SEPARATOR



The TV Sync Separator provides the trigger facilities for viewing composite video signals on a conventional oscilloscope. It can be used with Tektronix general-purpose oscilloscopes that have a 100-volt calibrator output. When used with other instruments, a separate 100-V source is required to power the unit.

A front panel switch selects field- or line-rate triggers, and a separate output jack supplies field triggers continuously. The unit has a clipping level control, allowing it to be used with signals ranging from 0.5 V to 8.5 V in amplitude.

POWER REQUIREMENTS—7 mA; operates on 100-V DC, or from the output of an oscilloscope calibrator with a frequency near 1 kHz.

INPUT—Composite video signal from signal source or from Vert Sig Out jack on front panel of oscilloscope.

OUTPUT—≈10-V negative-going composite sync for line rate triggering or ≈6-V negative-going field-rate triggers. Selected by toggle switch. Also second output for field-rate triggers.

TV SYNC SEPARATOR, with illustrated accessories, order 015-0062-00 ..... **$95.00**

VIDEO STAIRCASE DIFFERENTIATOR

The Video Staircase Differentiator permits the use of a general-purpose oscilloscope for measuring amplitude linearity in TV systems.

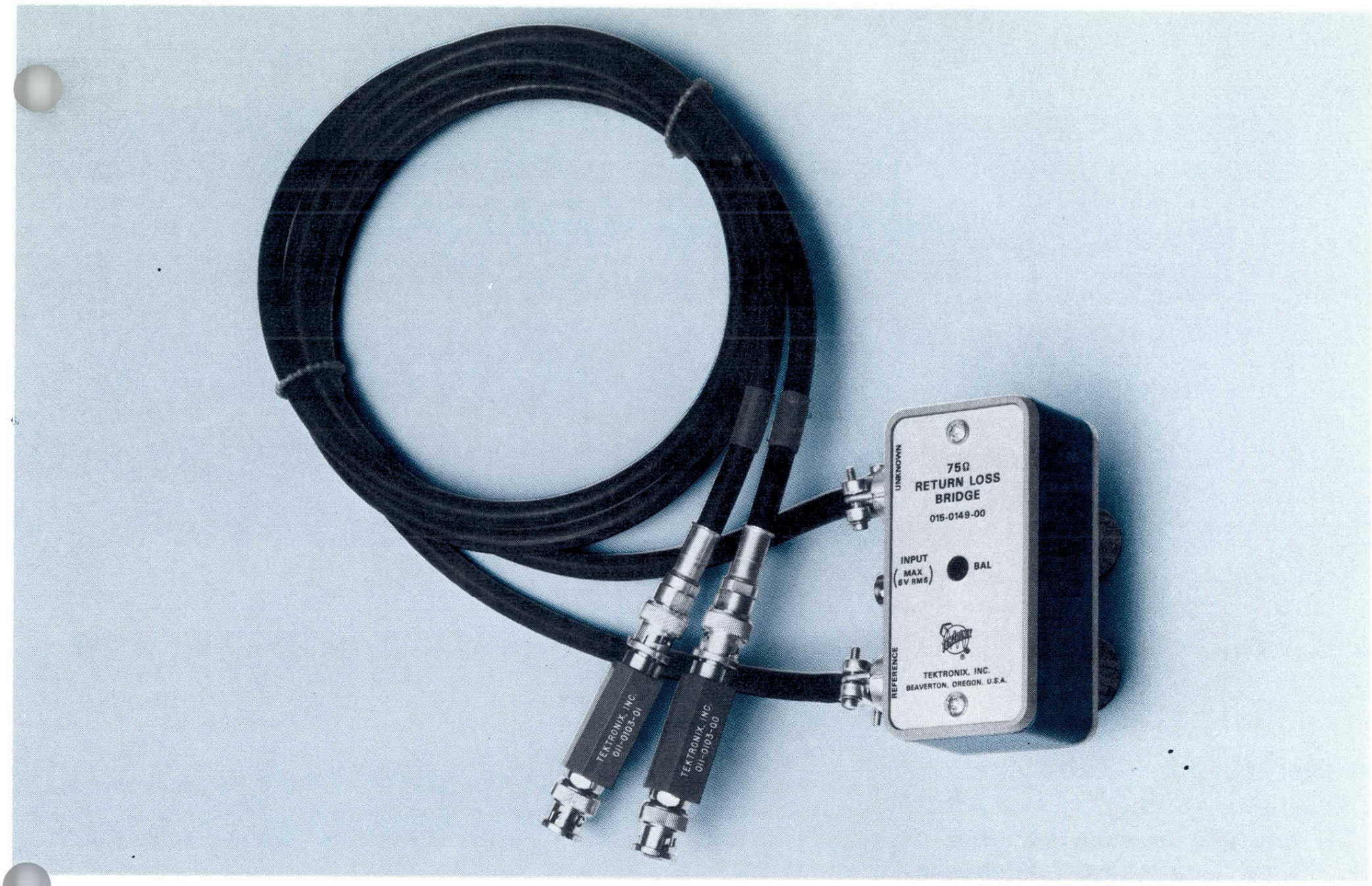
The staircase differentiator is a filter which differentiates the steps of an unmodulated, linearity staircase (VIT signal) into spikes. The spikes appear on a common-reference level. Amplitude linearity is checked by comparing the amplitude of the spikes on the oscilloscope display. The generator used must supply a staircase having equal risetime, for the output amplitude of the differentiator is proportional to the rate of rise. Input impedance of the differentiator is 75 ohms. Return loss is at least 36 dB.

VIDEO STAIRCASE DIFFERENTIATOR

UHF, order 015-0075-00 ..... $1[illegible]

BNC, order 015-0154-00 ..... $19.00

75Ω Return Loss Bridge



The Tektronix Return Loss Bridge is a compact and rugged device featuring passive components and simple construction. It is designed to measure impedance errors in a 75-Ω system in terms of return loss, using a wideband, high-gain differential amplifier and oscilloscope (TEKTRONIX Type 1A5/547 or 7A13/7504 or 7704) as the error detector. The TEKTRONIX 011-0103-00 and 011-0103-01 are 75 Ω, 0.2% double-ended termination resistors supplied as removable bridge arms. Two matched coax cables extend the bridge arms and are permanently attached to the bridge. The ability to disconnect either or both bridge arms provides for a maximum degree of flexibility, during both calibration and in making measurements.

The bridge can be driven by a number of different sources such as VIT test signals, squarewaves, sinewaves, sine-squared pulses, multiburst, and swept-frequency sinewaves. With the Return Loss Bridge coupled to the differential amplifier and oscilloscope, a television test signal such as the multiburst, can be used to measure impedance errors over the complete video spectrum with a single measurement.

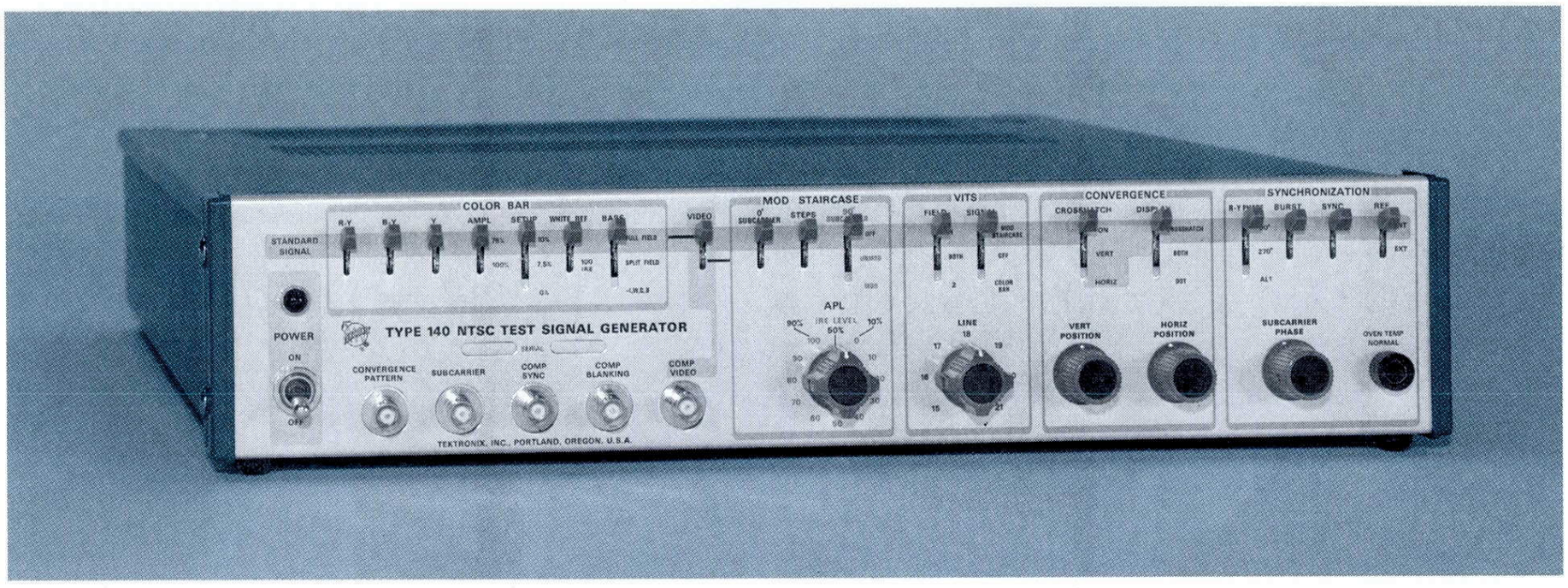
CHARACTERISTICS

RETURN LOSS—At least 54 dB, DC to 10 MHz.

MAXIMUM INPUT VOLTAGE—6 V RMS (6 V RMS, DC to 1.2 MHz decreasing to 0.7 V RMS at 10 MHz when used with Type 1A5 or 7A13).

RETURN LOSS BRIDGE, order 015-0149-00 . . . . . $100
Includes: two instruction manuals (070-1024-00).

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.



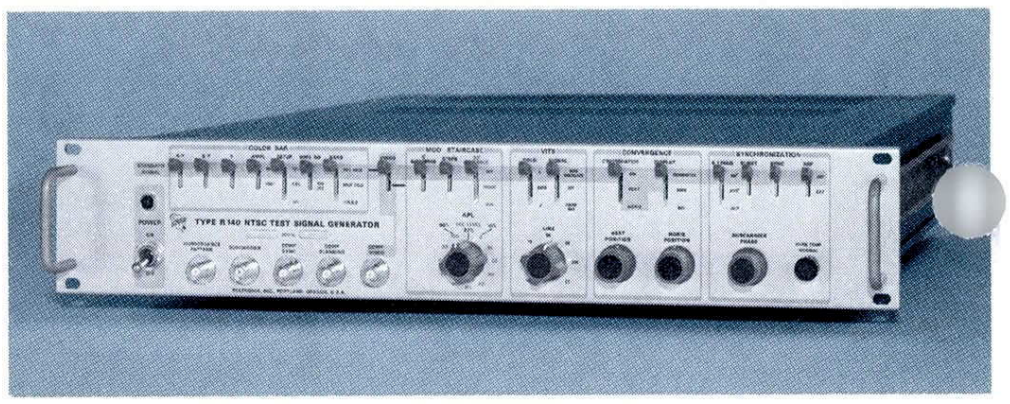
- ***NTSC ENCODED COLOR BARS***
  Conforms to EIA standard RS 189
  Full-field or split-field bars
  75% and 100% amplitude
  10%, 7½% or 0% setup

- ***MODULATED STAIRCASE***
  Conforms to IEEE standard IEEE 206
  Variable APL, 10% to 90%—fixed APL, 50%
  5 steps plus blanking level
  Subcarrier phase locked to burst

- ***CONVERGENCE CROSSHATCH***
  For picture monitor linearity evaluation in accord with IEEE standard IEEE 202
  For color picture monitor convergence adjustment

- ***VERTICAL INTERVAL TEST SIGNALS***
  Staircase or color bars
  Lines 15 through 21, either or both fields

- ***EIA SYNC GENERATOR AND COLOR STANDARD***
  Conforms with EIA standard RS 170



The Type 140 NTSC Test Signal Generator is a compact, solid-state source of high-quality television test signals for 525-line, 60-cycle field standard NTSC color TV systems. Combined in one compact unit are the test signals needed to accurately test, evaluate, and adjust laboratory and standard broadcast color video equipment. Each test signal not only strictly adheres to industry standards but provides additional refinements to enhance both the accuracy and range of measurements which can be made. The self-contained sync generator includes a temperature controlled color standard with excellent frequency stability. Digital integrated circuits are extensively used to achieve stability, accuracy, and reliability.

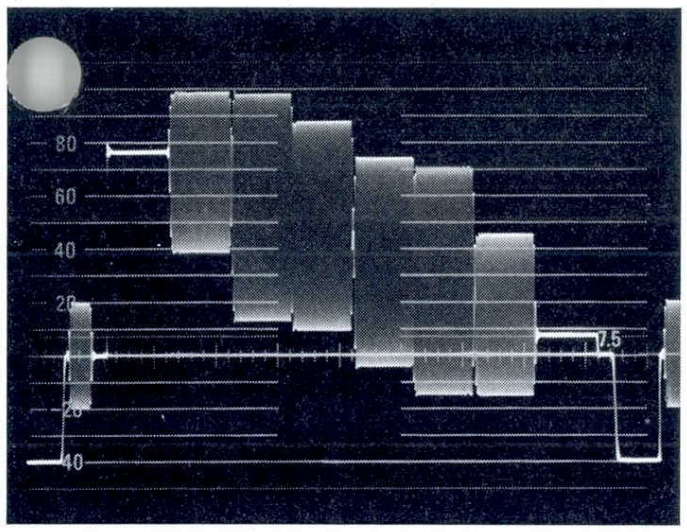


Fig 1: Full field color bars, 75% amplitude, 75% white reference, 7.5% setup.

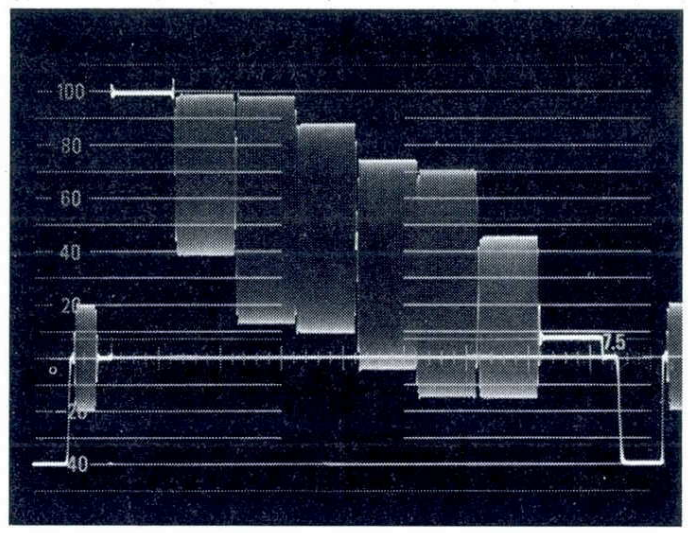


Fig 2: Full field color bars, 75% amplitude, 100 IRE white reference, 7.5% setup.

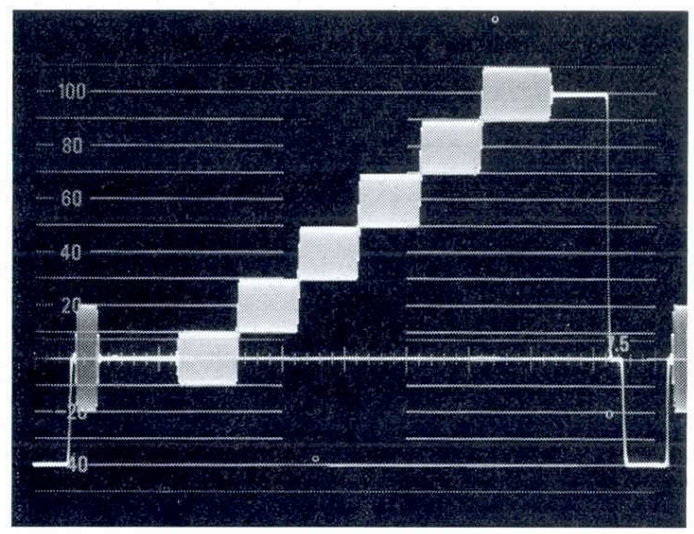


Fig 3: Modulated staircase signal with subcarrier.

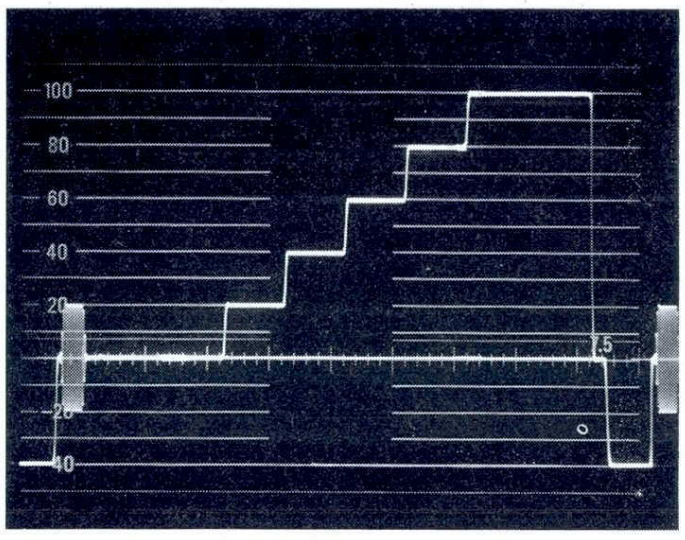


Fig 4: Modulated staircase signal, subcarrier off.

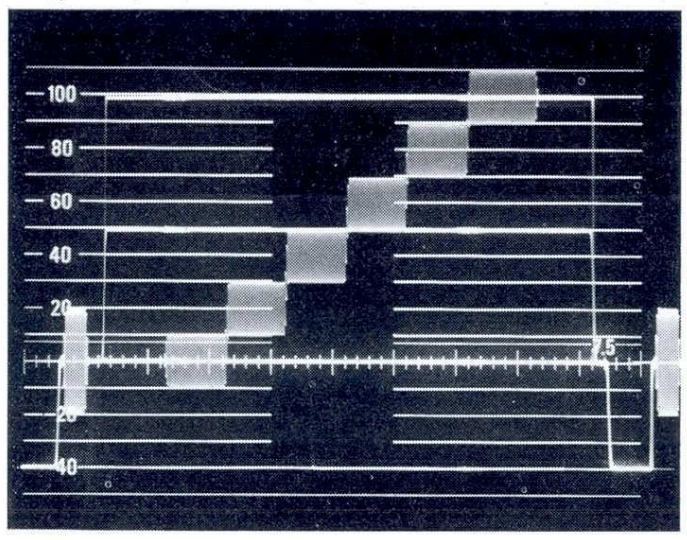


Fig 5: Multiple exposure, modulated staircase signal with subcarrier, variable APL, 10%, 50% and 90%.

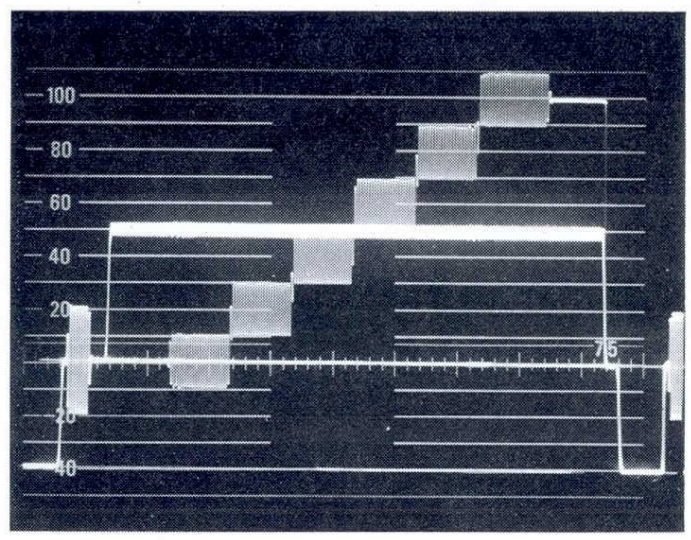


Fig 6: Modulated staircase signal with variable APL, 30 mV of subcarrier phased 90° to burst inserted on the 4 out of 5 variable lines which are at 50 IRE.

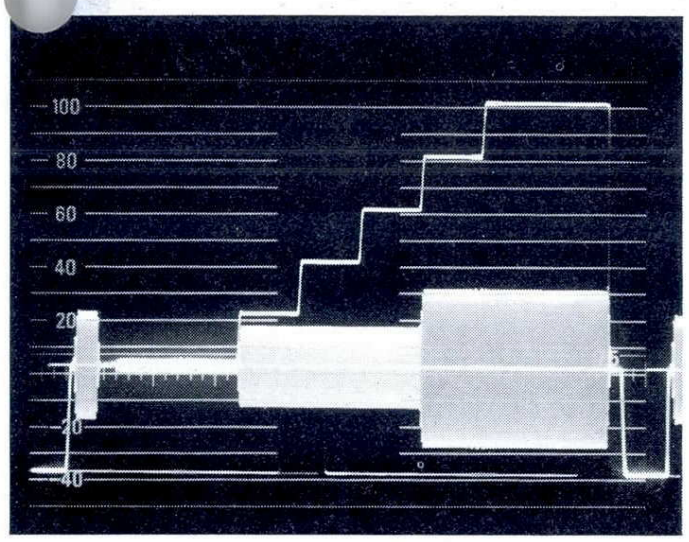


Fig 7: Staircase without modulation. Modulated 90° subcarrier on the 4 out of 5 lines at 0 IRE. Signal APL is 10%.

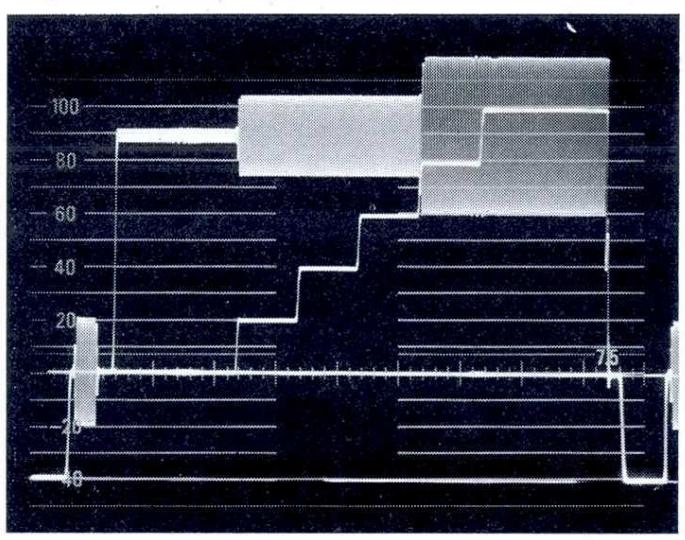


Fig 8: Staircase signal without modulation. Modulated 90° subcarrier on the 4 out of 5 lines at 90 IRE.

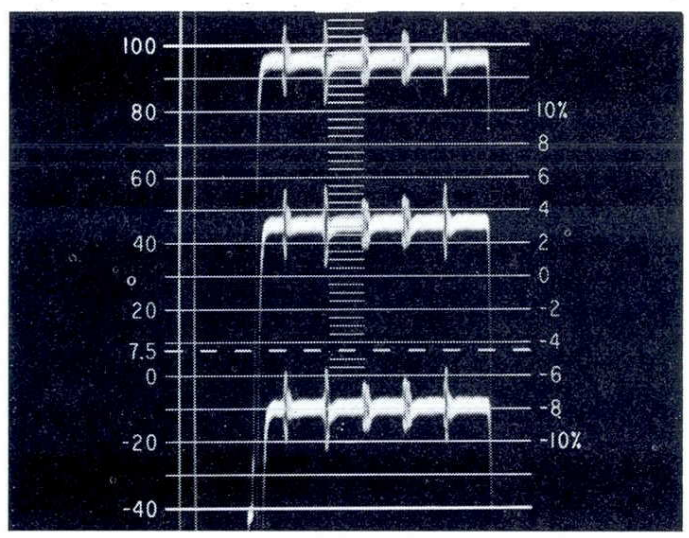
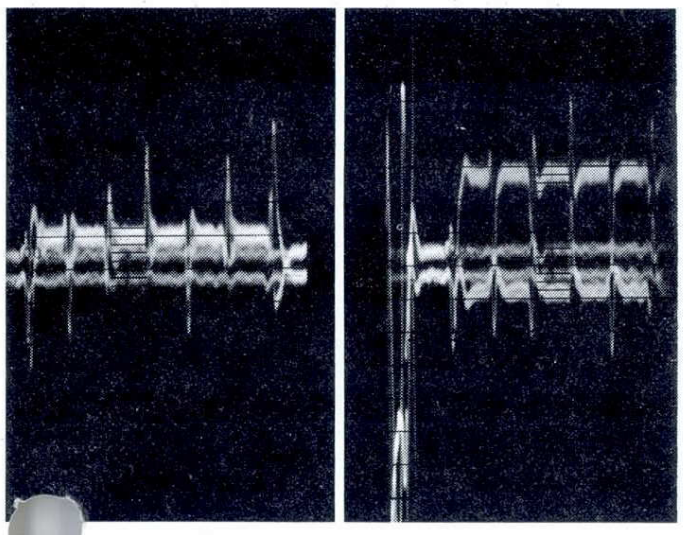


Fig 9: Triple exposure of modulated staircase viewed on a Type 520 Vectorscope in the differential gain mode. Top, 90% APL; middle, 50% APL; bottom, 10% APL.



10: Modulated staircase signal viewed on a Type 520 Vectorscope in the differential phase mode. Photo indicates combined differential phase of both instruments.

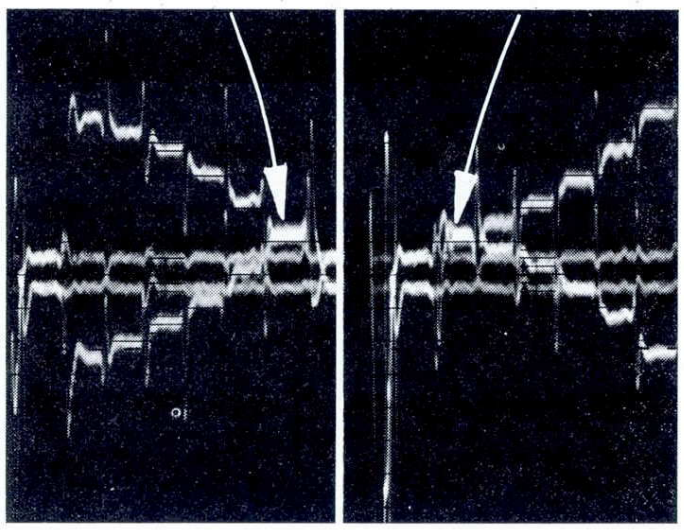


Fig 11: Double exposure. Left—Modulated staircase viewed on a Type 520 Vectorscope, differential phase mode, maximum resolution. Right—Same signal with the calibrated phase control changed 1°.

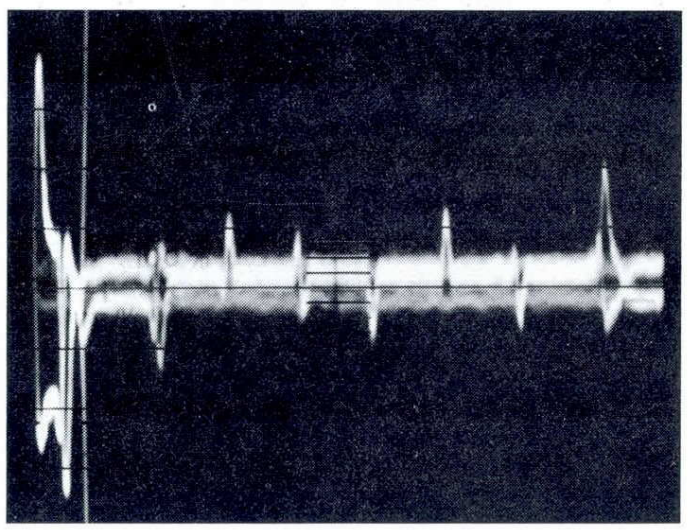


Fig 12: Double exposure. Differential phase of a typical video amplifer. From 0 IRE nulled (right) to 100 IRE nulled (left), phase shift is -1.8°.

NTSC COLOR BARS

NTSC color bars in descending luminance order in either full field or split field are provided by the Type 140. The composition of these signals is in accord with EIA color bar signal specification RS 189. In addition to basic signal requirements, these 100% saturated color bars are provided in either 75% or 100% amplitude with a choice of setup level. The white bar amplitude, which precedes the yellow bar, may be selected at 75% or 100% for 75% amplitude bars. The 100% white bar amplitude level permits a convenient check of relative chrominance/luminance gain by comparing the peak amplitudes of the yellow, cyan and white bars. An additional refinement to the full field color bar is a black reference bar following the blue bar.

LUMINANCE AND CHROMINANCE COMPONENT AMPLITUDE ACCURACIES

(Referenced at 25°C)—Amplitudes comply with the NTSC signal requirements as defined by the FCC. Absolute amplitudes of luminance signal, setup and sync are within 1% or 1.5 mV, whichever is greater. Absolute amplitudes of all subcarrier frequency components (chroma and burst) are within 3%. Relative amplitudes of all subcarrier frequency components (chroma and burst) are within 1% or 1.5 mV, whichever is greater.

BAR WIDTH—Full field bar width is 6.6 μs. Split field bar width is 7.5 μs.

WHITE REFERENCE—75% amplitude or 100% amplitude.

CHROMINANCE ENVELOPE RISETIME AND FALLTIME—375 ns within 15%.

SETUP—10%, 7½% and 0% available.

BLANKING TO PEAK WHITE AMPLITUDE—714 mV (independent of setup).

LUMINANCE RISETIME AND FALLTIME—100 ns within 15%.

—I AND Q CHROMINANCE SIGNAL WIDTH—9.4 μs on the same lines as black and white references, amplitude of each within 1% of burst amplitude.

MODULATED STAIRCASE

The modulated staircase signal is provided with a choice of variable APL from 10% to 90% (0 to 100 IRE) in ten equal increments (11 levels), or a fixed APL of 50%.

The staircase luminance component consists of five 20-IRE-unit risers. The subcarrier component is phase locked to color burst. The signal is in strict conformity with IEEE Standard, IEEE 206 and the definition of APL is rigorously observed. Applications include measurements of differential gain and phase, dynamic gain, luminance signal linearity, luminance signal distortion caused by chrominance signal non-linearity and burst phase errors.

A new signal capability provides a means to check luminance signal distortion caused by rectification of the subcarrier signal. When the variable APL mode is selected, an additional component consisting of subcarrier, phased to lead burst by 90°, may be added to the low-frequency lines either as a constant 30-mV amplitude signal or amplitude modulated to produce 30-mV, 305-mV and 610-mV amplitudes. The modulated amplitude subcarrier signal position is useful for determining the effects of subcarrier rectification upon luminance signals at all APL's through the entire TV system. The constant 30 amplitude subcarrier signal is useful for eliminating unnecessary portions of the display when making differential phase measurements.

LUMINANCE COMPONENT—5 step amplitude is 714 mV within 1%. Single step amplitude is 143 mV within 1%. Step risetime is 260 ns within 15% and aberrations are within 2%. Step duration at blanking level and at white level is 13.2 μs within 5%. Intermediate step durations are 6.6 μs within 5%.

CHROMINANCE COMPONENT—Amplitude is 143 mV P-P within 3%. Phase is 0°.

DIFFERENTIAL PHASE—0.1° or less.

DIFFERENTIAL GAIN—0.5% or less.

SUBCARRIER ENVELOPE—Risetime is 260 ns within 15% and duration is 40 μs within 5%. Envelope delay from horizontal sync is 16.1 μs within 5%.

50% FIXED APL—Each active line carries the modulated staircase signal. APL is 50% per IEEE standard, IEEE 206.

VARIABLE APL—Staircase signal is on every 5th line and the same line each frame. The variable amplitude low-frequency signal is on the remaining 4 out of 5 lines. APL range is 10% to 90% in 10 equal increments (11 levels).

VARIABLE APL LINES

Luminance Component—Adjustable in 10 equal increments from 0 IRE to 100 IRE. 0 IRE position provides 10% 50 IRE position provides 50% APL and 100 IRE position provides 90% APL.

Subcarrier Component—A three-position switch controls the insertion of subcarrier on the low-frequency lines. Positions are: subcarrier off; unmodulated subcarrier; and modulated subcarrier. The unmodulated position provides 30 mV P-P (approx 5 IRE at 90°) during active line time of 52.3 μs. The modulated subcarrier position provides 30 mV within 3% for approx 13 μs, 305 mV within 3% for approx 20 μs (corresponding to 6-dB amplitude reduction from the amplitude of chrominance on 75% amplitude red and cyan bars) and 610 mV within 3% for the last 20 μs of the active line time (corresponding to the chrominance amplitude of 75% amplitude red and cyan bars phased at 90°). Incidental phase errors between 30-mV, 305-mV and 610-mV signals is 0.5° or less.

CONVERGENCE PATTERN

The convergence pattern signal is provided separate and independent from the other test signals. It is useful for measuring picture monitor or camera scanning linearity, aspect ratio and geometric distortion. It conforms to IEEE standard, IEEE 202.

DISPLAYS AVAILABLE—Cross hatch; vertical lines only; horizontal lines only; dots only; and cross hatch plus dots (dots appear centered in the rectangles formed by the cross-hatch pattern).

CONVERGENCE PATTERN SIGNAL CHARACTERISTICS—P-P amplitude is 1 V within 5%. Pulse amplitude is 714 mV within 5%. Sync amplitude is 286 mV within 5%. Setup is 72 mV within 5%.

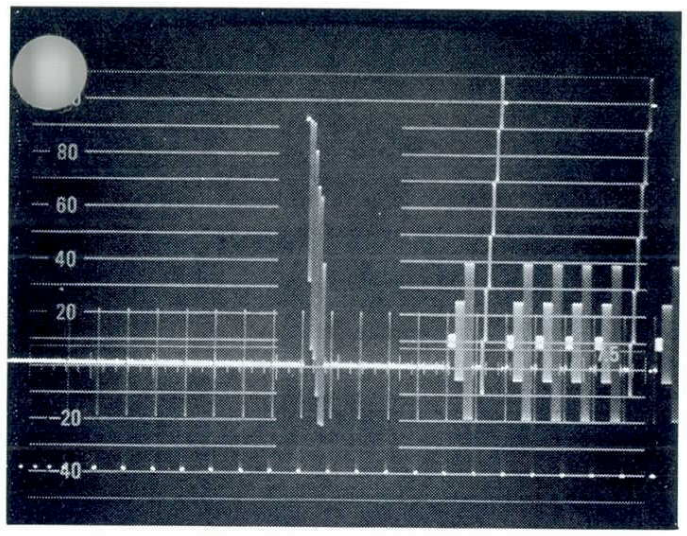


Fig 13: Color bars inserted during vertical interval. The full field signal is a modulated staircase, variable APL, 90° modulated subcarrier inserted.

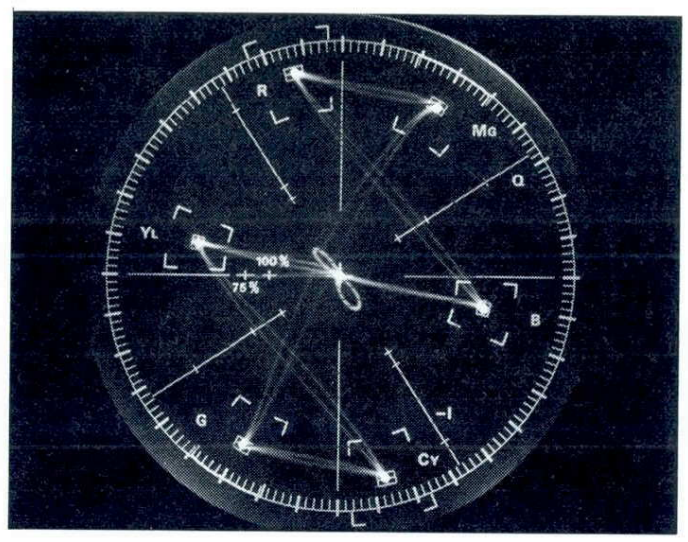


Fig 14: Vector display of VITS color bars from the Type 140.

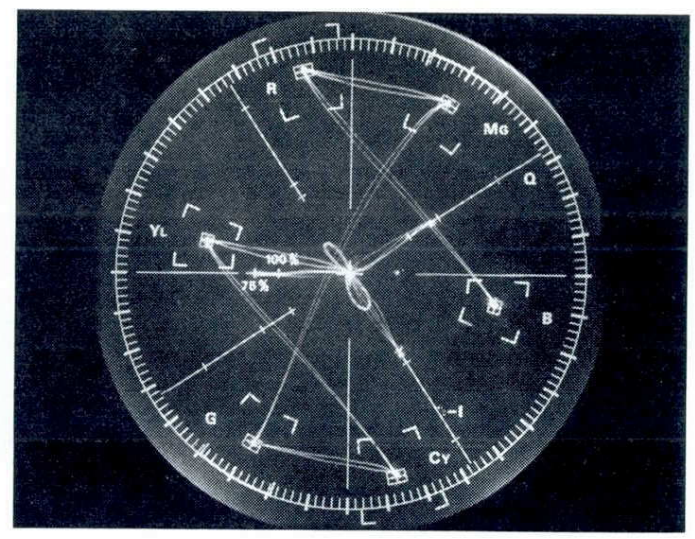


Fig 15: Vector display. Split field color bars, 75% amplitude, 100% white reference, 10% setup. Conforms to EIA specification RS 189.

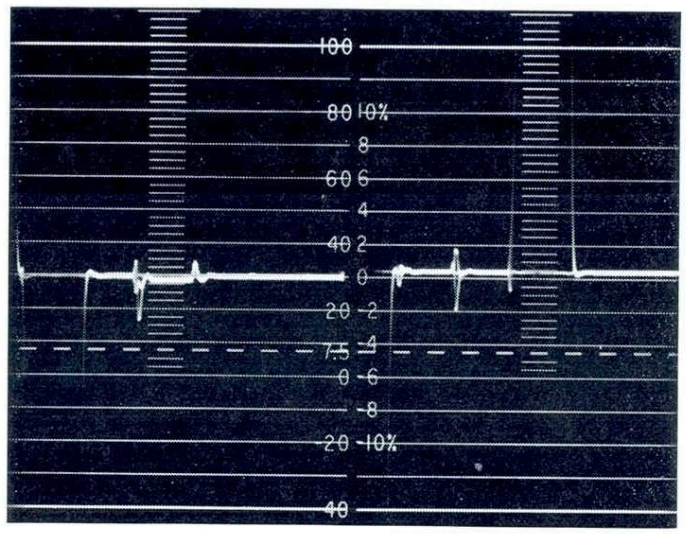


Fig 16: Double exposure (left and right) of the -I, W, Q and B bars with the I and Q depressed.

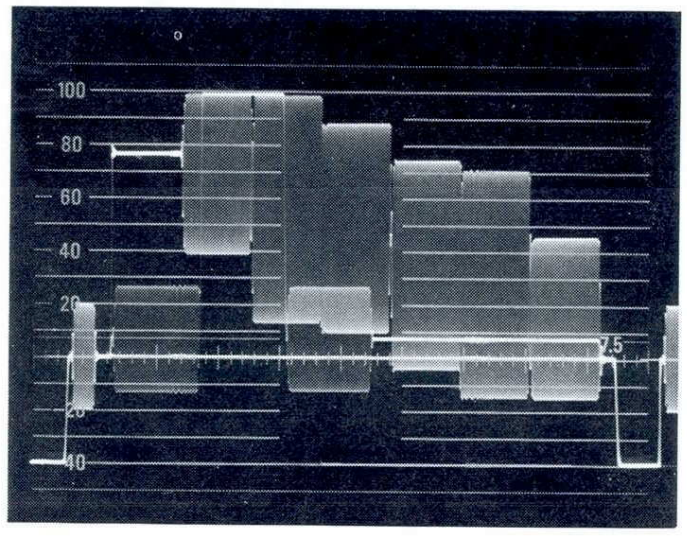


Fig 17: Split field color bars per EIA specification RS 189.

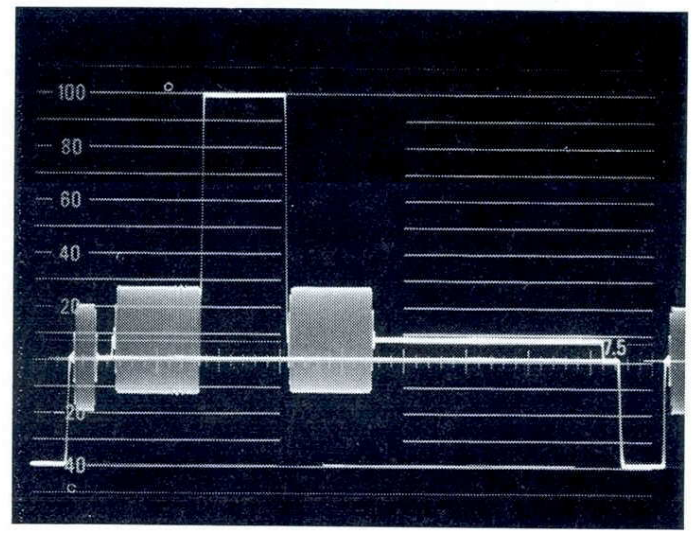


Fig 18: Display of -I, W, Q and B.

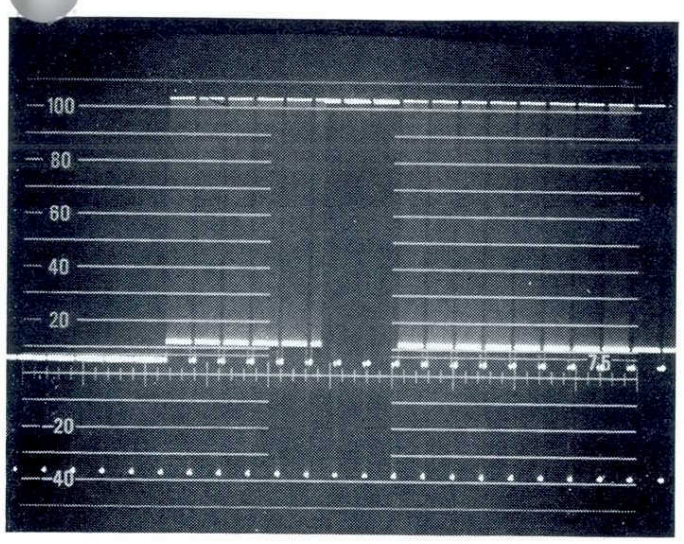


Fig 19: Convergence pattern, white cross hatch.

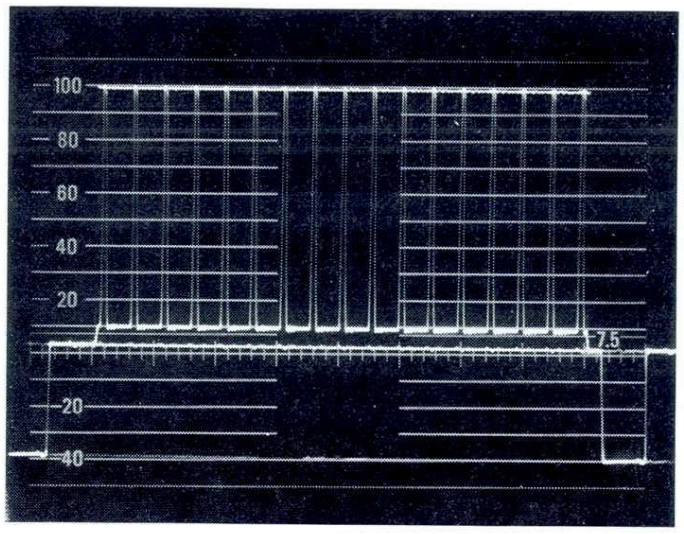


Fig 20: Line display of the convergence cross hatch signal.

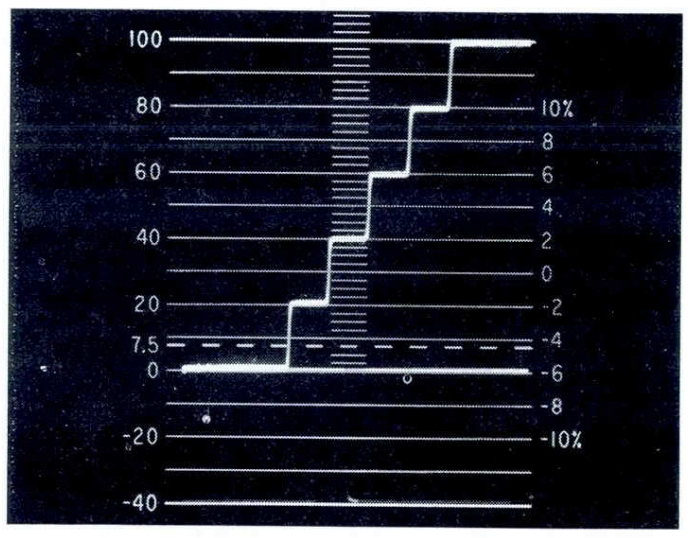
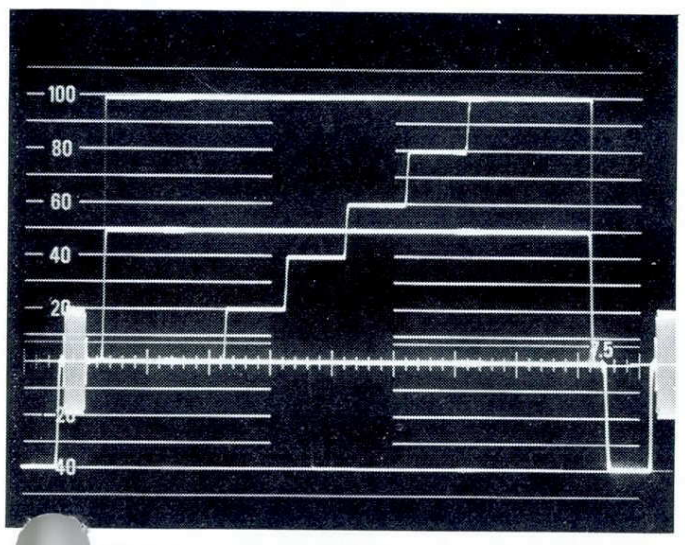


Fig 21: Modulated staircase signal through the luminance (Y) channel of the Type 520 NTSC Vectorscope.



22: Multiple exposure. Staircase signal, variable APL, 10%, 50% and 90%.

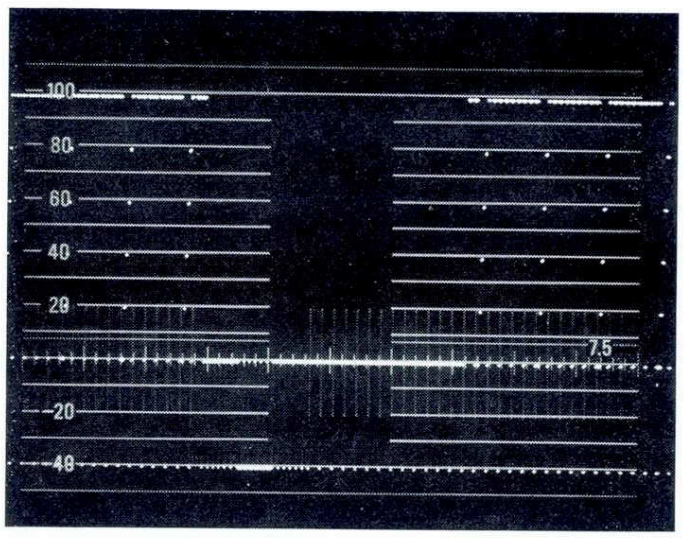


Fig 23: Staircase signal with variable APL. Staircase signal occupies every 5th line and the same lines every field.

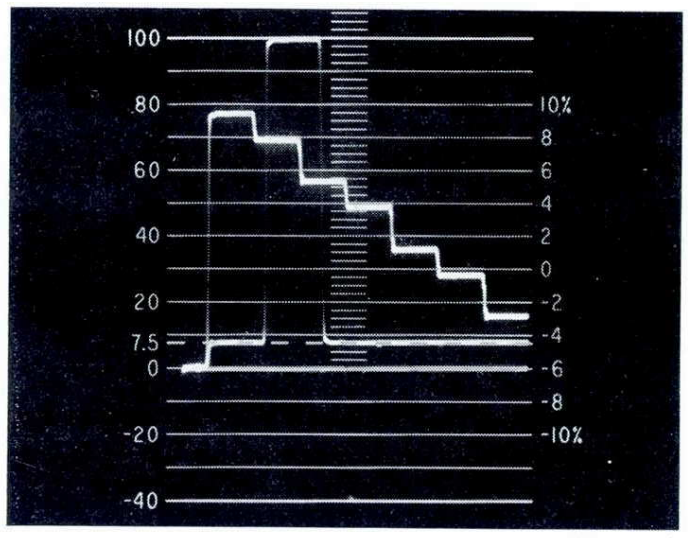
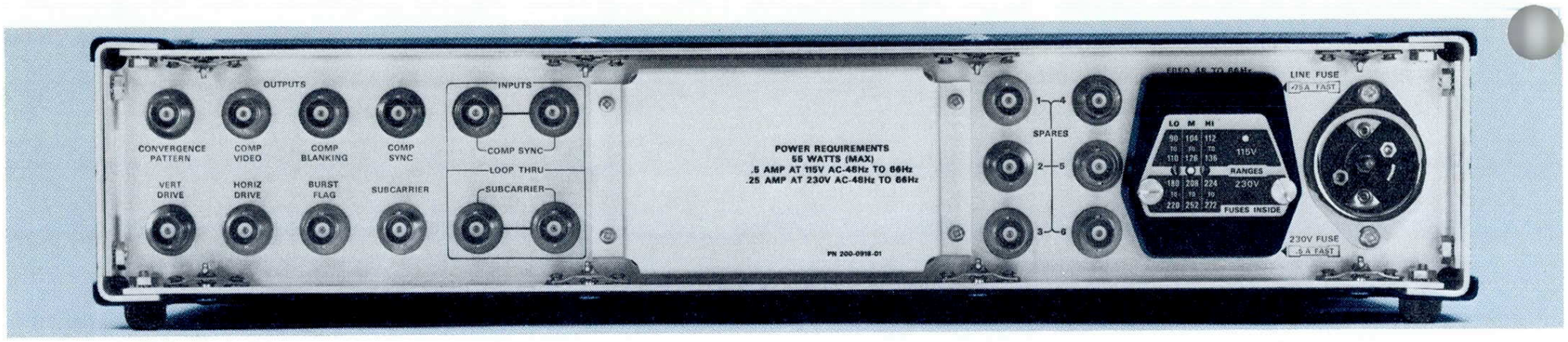


Fig 24: Luminance component of the split field color bars as viewed on the Type 520 NTSC Vectorscope.



VERTICAL INTERVAL TEST SIGNALS

A provision is made for insertion of either the staircase or the color bar, as a vertical interval test signal, on any line from 15 through 21 of either or both fields. The phase of the burst (and all other subcarrier frequency components of the test signal outputs) may be varied 360° with respect to the subcarrier frequency source (internal or external).

With the 75% amplitude full field color bar signal or the modulated staircase signal inserted on an appropriate line of both fields, it is possible to test an entire video system including transmitters for differential phase and gain and verify if the actual phase and amplitude errors of the chrominance at all APL's conforms to FCC rules.

SYNC GENERATOR AND COLOR STANDARD

The EIA sync generator circuitry is largely digital, using integrated circuitry for counting functions. The usual frequency multiplier circuits and their attendent problems have been avoided resulting in exceptional time stability. Internal controls permit some variation of widths including burst flag timing. These adjustments are preset to conform to FCC standards.

The color standard has a proportional control oven for the quartz crystal and the entire oscillator circuit. The frequency stability achieved is well within FCC specifications. A front-panel lamp indicates proper operation of the oven. When the internal color standard is used, the phase of the color subcarrier output is variable over a 360° range with respect to the phase of the burst contained in the video output. When an external color standard is used the phase of the burst (and all other subcarrier frequency components of the test signal outputs) may be varied 360° to the external subcarrier source.

SUBCARRIER—frequency is 3.579545 MHz within 5 Hz.

Outputs—Subcarrier outputs are provided on the front and rear panels. Output impedance is 75 Ω within 5%. Isolation is at least 30 dB. Output level is 2 V P-P within 0.2 V into 75 Ω.

Input—Subcarrier input requires 1 V to 4 V. Return loss is at least 46 dB at 3.58 MHz.

COMPOSITE SYNC

Input—Required amplitude is 2 V to 8 V, negative-going. Return loss is at least 46 dB using loop-through inputs.

Output—A front-panel and a rear-panel output is provided. Output level is 4 V within 0.2 V into 75 Ω. Return loss is at least 30 dB to 5 MHz. Isolation is at least 40 dB. Risetime is 115 ns within 10%.

HORIZONTAL DRIVE—Output level is 4 V within 0.2 V into 75 Ω.

VERTICAL DRIVE—Output level is 4 V within 0.2 V into 75 Ω.

BURST FLAG OUTPUT—Output level is 4 V within 0.2 V into 75 Ω. Risetime is 115 ns within 10%.

COMPOSITE BLANKING OUTPUT—Output level is 4 V within 0.2 V into 75 Ω. Isolation is at least 30 dB. Risetime is 115 ns within 10%.

BURST—Breezeway is at least 379 ns. Risetime is 375 ns within 15%. Envelope duration is 2.22 to 2.61 μs. Time duration from leading edge of sync pulse (10% amplitude reference) to trailing edge of burst envelope (10% amplitude reference) is 7.94 μs or less. Burst amplitude is 286 mV P-P within 3%.

HORIZONTAL BLANKING WIDTH—11.1 μs (digitally determined from 3.579545 MHz).

FRONT PORCH WIDTH—15.4 μs within 0.05 μs.

LINE SYNC PULSE WIDTH—4.71 μs within 0.05 μs.

LINE SYNC PULSE RISETIME—115 ns within 10%.

VERTICAL BLANKING—21 lines (digitally determined from 3.579545 MHz).

COMPOSITE VIDEO OUTPUT—Outputs are provided on the front and rear panels. Amplitude is 1-V P-P into 75 Ω. Return loss is at least 30 dB from DC to 5 MHz.

OTHER CHARACTERISTICS

POWER REQUIREMENTS—90-136 VAC or 180 to 272 VAC, 48 Hz to 66 Hz, 55 watts maximum at 115 VAC and 60 Hz. Rear-panel selector provides rapid accommodation for 6 line-voltage ranges.

AMBIENT TEMPERATURE—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C (except as noted).

TYPE 140 DIMENSIONS AND WEIGHTS

Height	3½ in	8.9 cm
Width	16¾ in	42.6 cm
Depth	18½ in	47.1 cm
Net weight	17¾ lb	8.0 kg

TYPE R140 DIMENSIONS AND WEIGHTS

Height	3½ in	8.9 cm
Width	19 in	48.3 cm
Depth	18½ in	47.1 cm
Net weight	18½ lb	8.4 kg

INCLUDED STANDARD ACCESSORIES

75-Ω, through-line termination (011-0103-02); two instruction manuals (070-0944-00); power cord (161-0036-00).

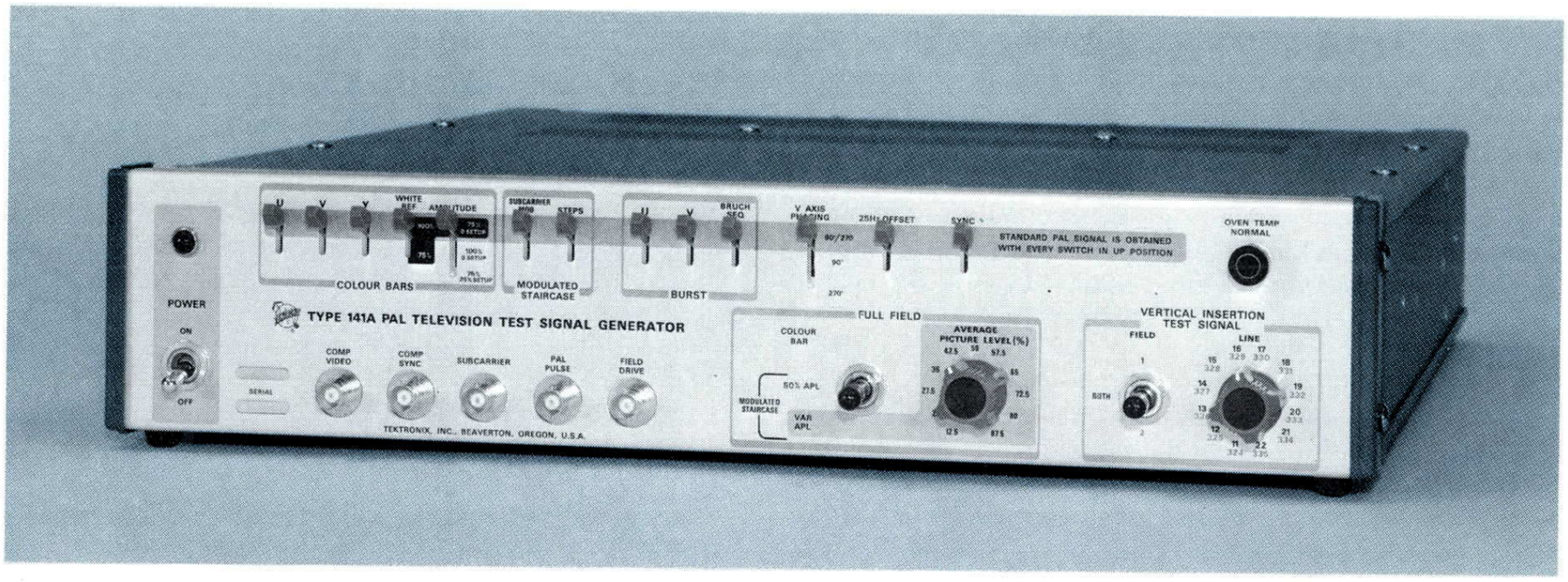
Type R140 also includes rackmounting hardware.

TYPE 140 NTSC TEST SIGNAL GENERATOR **$1800**

TYPE R140 NTSC TEST SIGNAL GENERATOR (rackmo
..... **$1800**

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

PAL TV Signal Generator



- ***PAL COLOUR BARS***

  EBU bars—75% amplitude, 100% saturated, 0% setup, 100% white reference (75% white reference also selectable)

  BBC 95% bars—75% amplitude, 100% saturated, 25% setup, 100% white reference

  100% bars—100% amplitude, 100% saturated, 0% setup, 100% white reference

- ***MODULATED STAIRCASE***

  Fixed or variable APL

- ***VERTICAL INSERTION TEST SIGNAL***

  Modulated staircase

  Field 1, Field 2, or both

The Type 141A PAL Television Test Signal Generator is a source of high-quality television test signals for 625-line, 50-cycle field standard PAL colour TV Systems. The all solid-state Type 141A utilizes Digital Integrated Circuits to achieve stability, accuracy and reliability.

Three operating modes provide PAL Colour Bars, a 5-Step Staircase with fixed Average Picture Level (APL), and the same Staircase with variable APL. The colour bar output is a full-field test signal appearing on every active line and consists of 75% amplitude colour bars in descending luminance order with 0% setup. The white reference can be be set at 75% or at 100% (for standard EBU bars). Two other versions of colour bar signal can be selected: 75% amplitude, 100% white reference with 25% setup (BBC 95% bars) and 100% amplitude, 100% white reference, 0% setup (100% bars). Any component of the composite video colour signal may be turned off. This includes Y, U, V, the entire colour bar signal, sync, burst (either U or V component only or both), and the 25-Hz offset of colour subcarrier which drives the sync generator.

The staircase signal is particularly useful with a Tektronix Type 521 PAL Vectorscope to measure differential phase and differential gain. Luminance channel linearity may also be measured using the Tektronix video staircase differentiator part #015-0075-00 (the transient response of the staircase signal component is determined by a $\sin^2$ filter whose cut-off frequency limits the energy content in the region of the colour subcarrier frequency).

The PAL subcarrier (140 mV P-P) is accurately phased at 180° (it lies along the —U PAL axis and is at the same phase on alternate lines). Subcarrier may be switched off when desired.

To provide VITS (Vertical Insertion Test Signal) the staircase signal is keyed on during a selected line of the vertical blanking interval, either or both fields (line 11-22 on Field 1 and line 324-335 on Field 2).

Normal PAL colour burst is provided on the staircase and colour bar signals. The complex four-field Bruch blanking sequence during vertical interval is provided and may be switched off if desired.

A 1-MHz reference signal which is frequency "locked" to the 4.43361875-MHz PAL subcarrier oscillator is provided at the rear of the instrument. The accuracy of the internal subcarrier oscillator may be conveniently verified by comparing the 1-MHz reference with known frequencies, such as the Droitwich 200-kHz radio transmissions in Europe.

The Type 141A is available in either rackmount (R141A) or cabinet (141A) styles.

PAL TV Signal Generator

COLOUR BARS

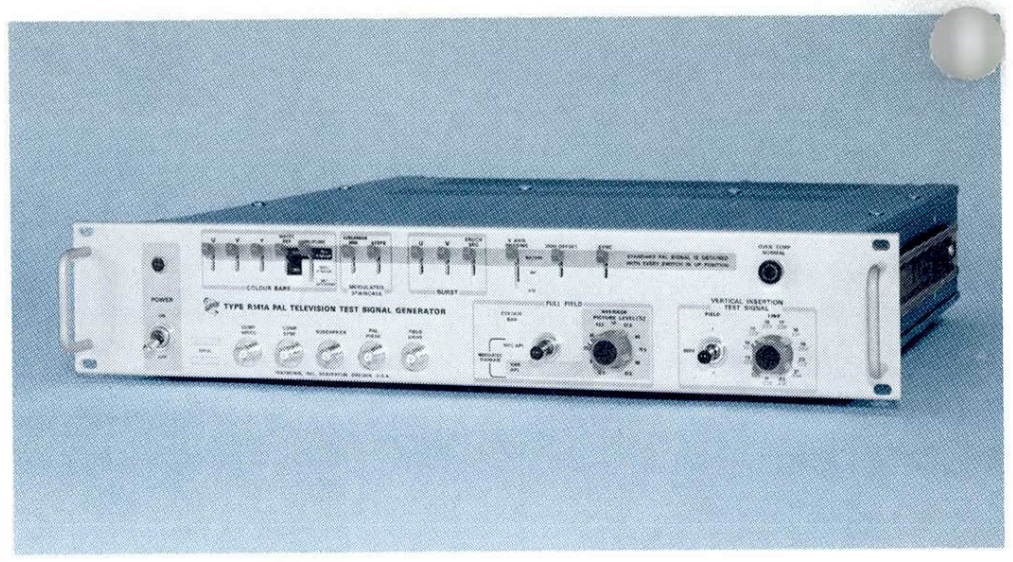
LUMINANCE AND CHROMINANCE AMPLITUDE ACCURACIES (25°C reference) Component amplitudes comply with the CCIR signal requirements as defined by CCIR, 11th Plenary Assembly, 1966, Vol. 5, p. 281. Absolute amplitudes of luminance signal, setup and sync are within 1% or 1.5 mV, whichever is greater. Absolute amplitudes of all subcarrier frequency components (chrominance, U and V) are within 3%. Relative amplitudes of all subcarrier frequency components (chrominance and burst) are within 1% or 1.5 mV, whichever is greater.

BAR WIDTH—6.5 μs within 5%.

WHITE REFERENCE—100% amplitude (normal); or 75% amplitude.

CHROMINANCE—Time difference between luminance and chrominance channels is 20 ns or less. Risetime is 260 ns within 10%. U, V quadrature error is 0.5° or less, V axis phase-switcher error is 0.5° or less.

RESIDUAL SUBCARRIER—At least 52 dB below 1 V except 30 dB at end of H blanking. Aberrations are not more than 4% P-P. Spurious subcarrier is at least 52 dB below 1 V. Other spurious outputs are at least 52 dB below 1 V.



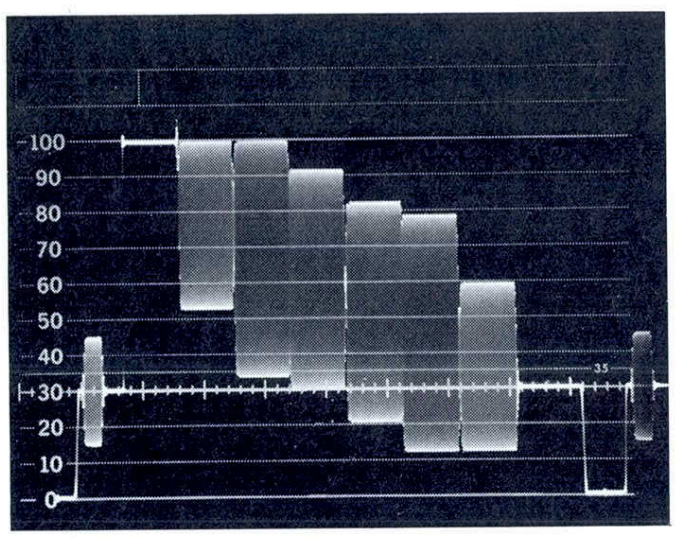
MODULATED STAIRCASE

LUMINANCE COMPONENT—5-step amplitude is 700 mV within 1%. Single-step amplitude is 140 mV within 1%. Step risetime is 260 ns within 15%. Step duration at blanking level and white level is 13 μs within 5%. Intermediate step durations are 6.5 μs within 5%. Aberrations are within 2%.

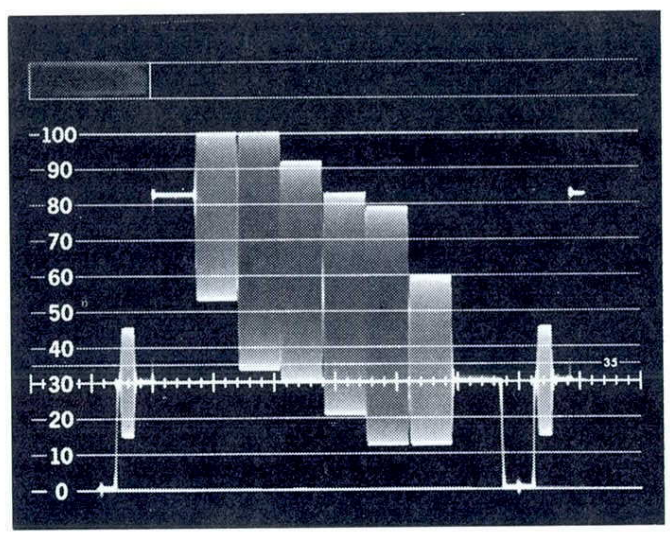
CHROMINANCE COMPONENT—Amplitude is 140 mV P-P within 3%. Phase is 180°.

DIFFERENTIAL PHASE—0.1° or less.

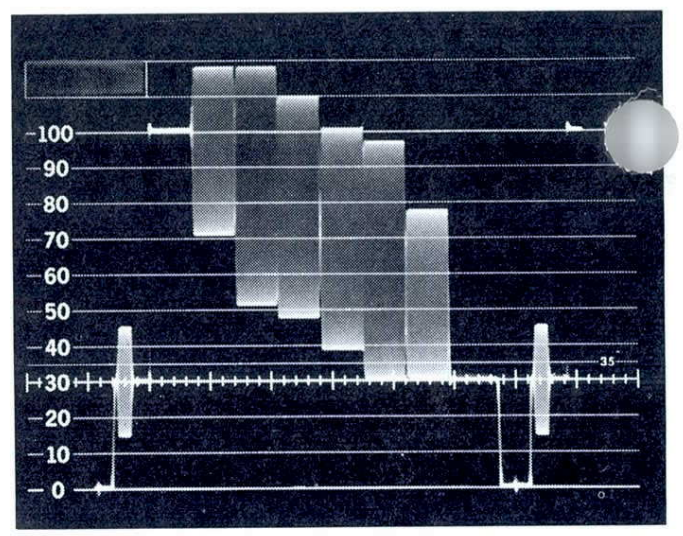
DIFFERENTIAL GAIN—0.5% or less at 0%, 50% and 100% APL.



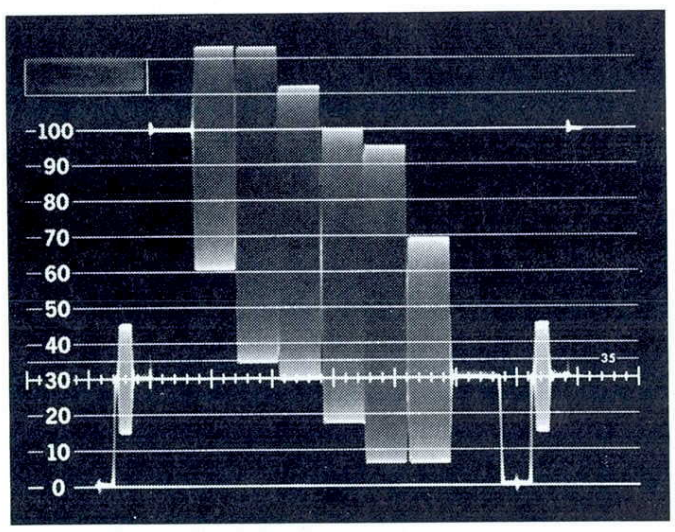
EBU colour bars—75% amplitude, 100% saturation, 0% setup and 100% white reference.



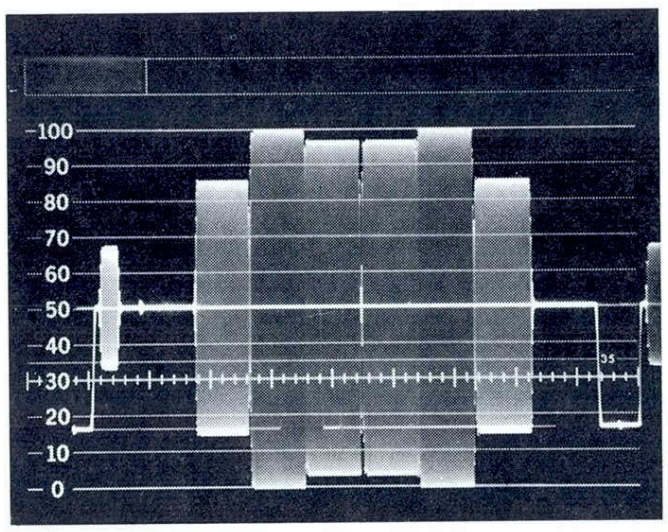
EBU colour bars—75% amplitude, 100% saturation, 0% setup and 75% white reference.



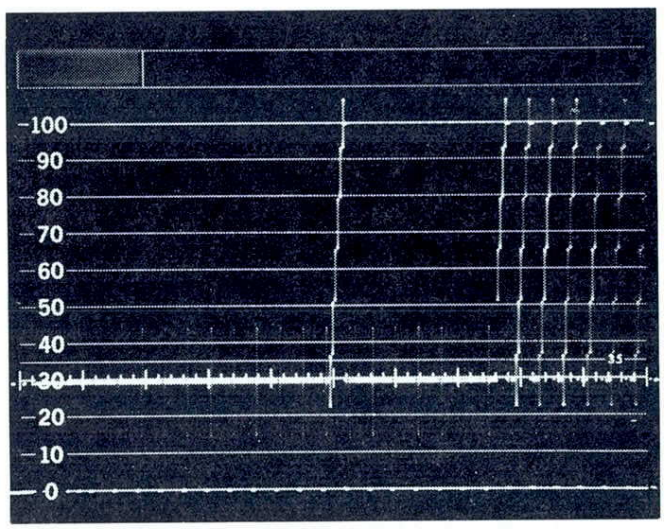
BBC 95% colour bars—75% amplitude, 100% saturation, 25% setup and 100% white reference.



100% colour bars—100% amplitude, 100% saturation, 0% setup, 100% white reference.

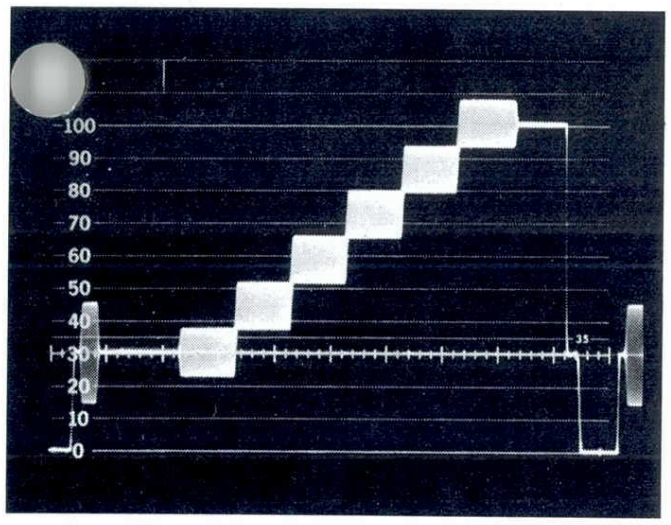


PAL colour bars, luminance component switched off (vertical gain of waveform monitor increased).

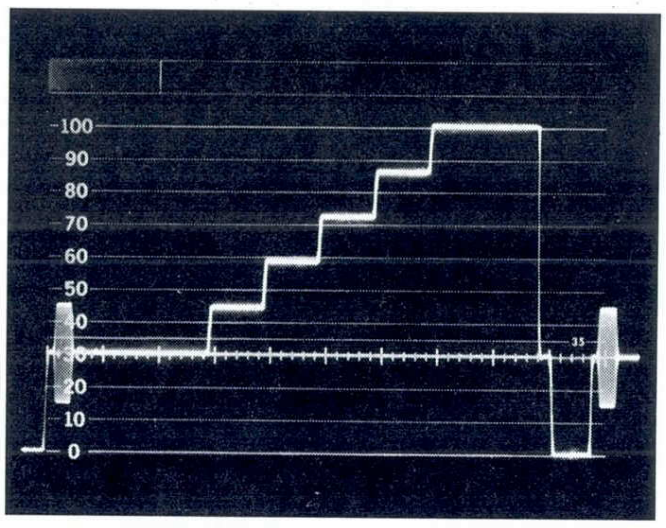


Vertical Insertion Test Signal, 5-step staircase with PAL subcarrier on line 16, field 1.

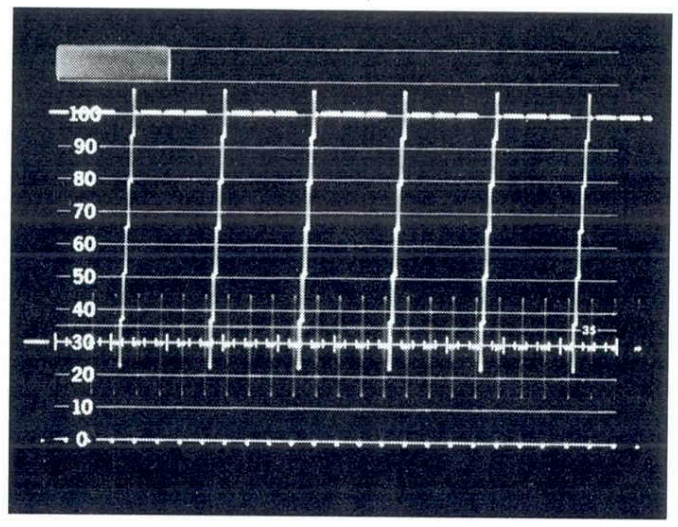
PAL TV Signal Generator



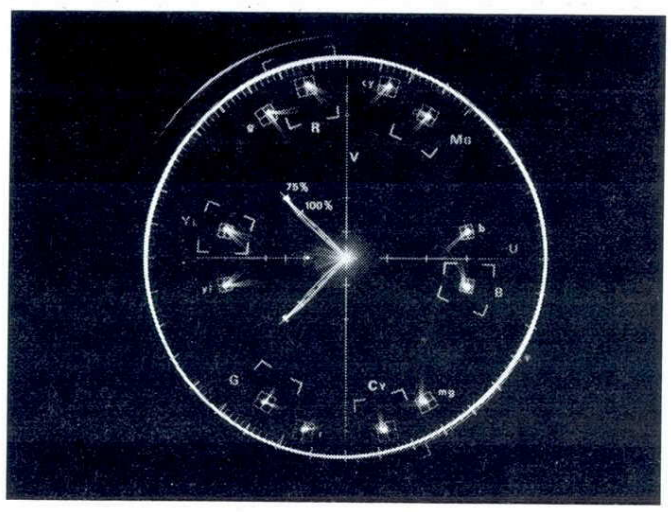
5-step staircase waveform with PAL subcarrier along -U axis. PAL burst is provided. Note white reference level following the modulation.



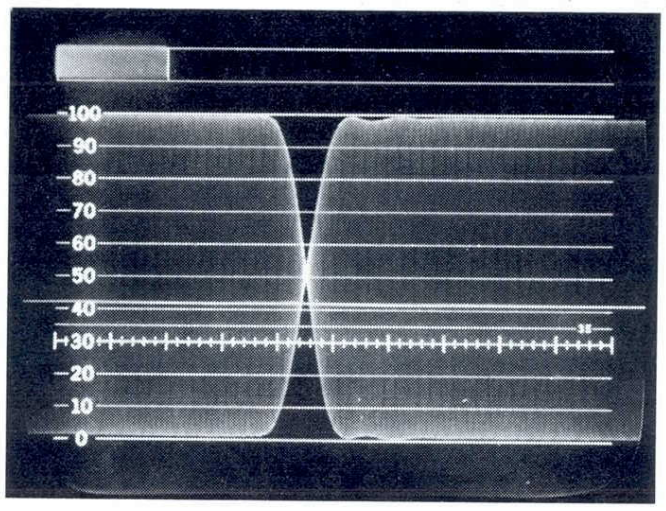
5-step staircase waveform, luminance only. Note double width black and white steps. Luminance transitions are $\sin^2$ shaped of approx 260-ns risetime.



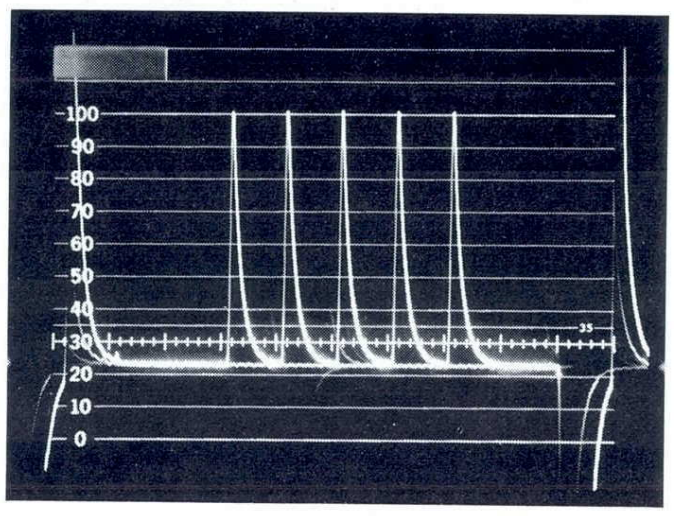
Staircase signal with variable average picture level (shown at 100). Every fourth line in successive frames carries the stairstep signal. APL variable in 11 equal steps from black to white.



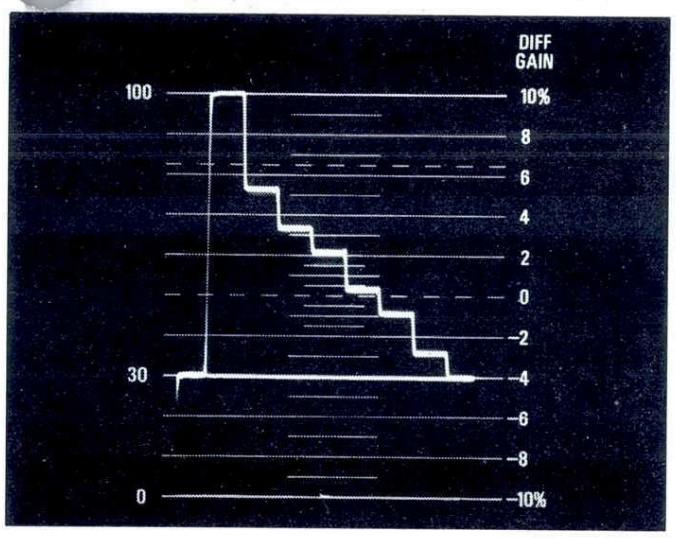
Vector PAL presentation of PAL colour bar.



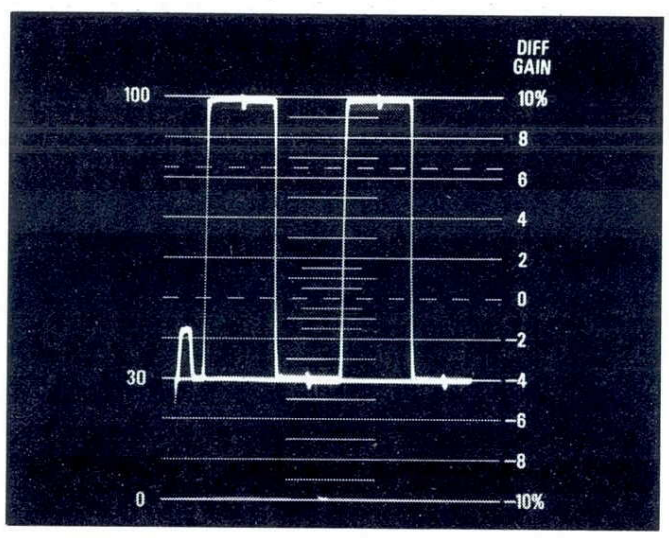
Chrominance signal, green-magenta transition, 250 ns/cm time base.



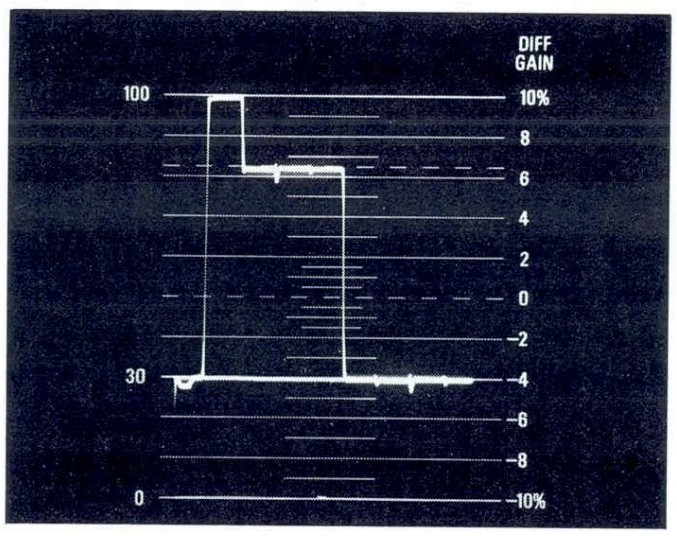
Stairstep luminance signal showing exact equality of individual transitions when differentiated by Tektronix Video Staircase Differentiator (part number 015-0075-00).



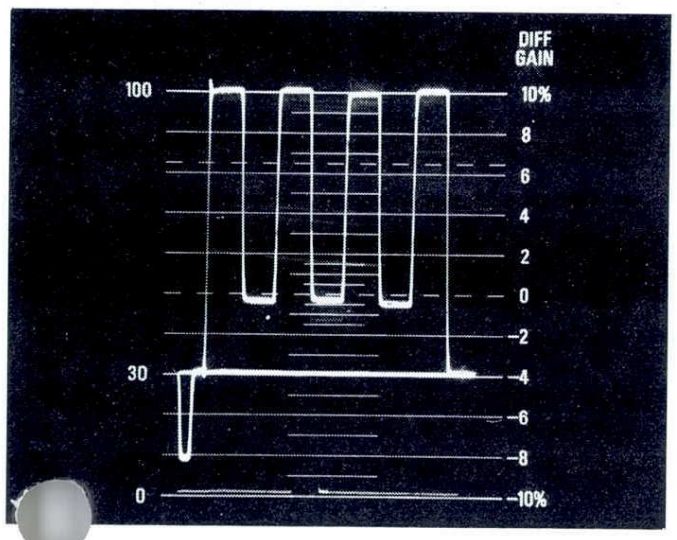
PAL colour bars, luminance signal only, 75% amplitude with 100% white reference.



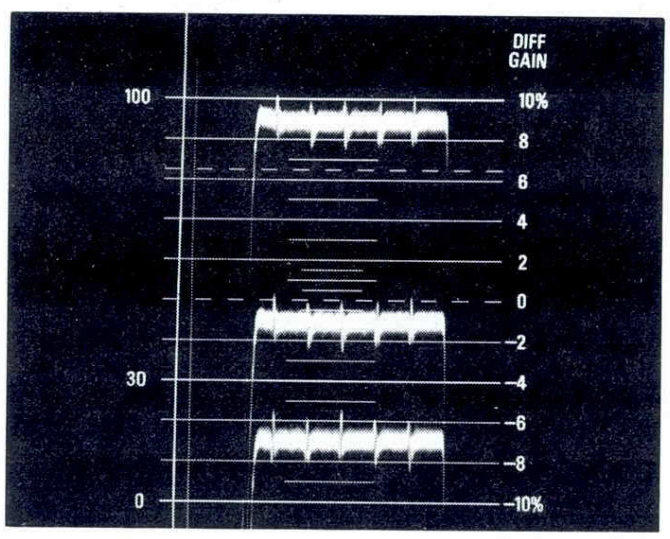
PAL colour bars, 100% amplitude, 100% white reference, demodulated to recover the RED signal.



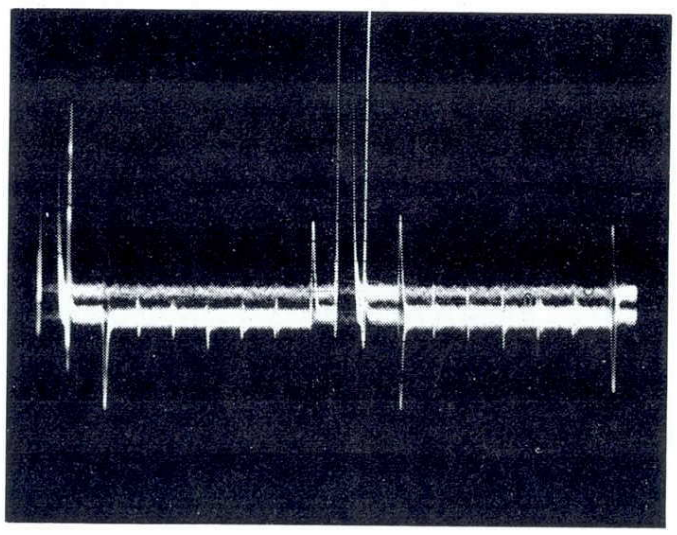
PAL colour bars, 75% amplitude, 100% white reference, demodulated to recover the GREEN signal.



PAL colour bars, 75% amplitude, 100% white reference, 25% setup, demodulated to recover the BLUE signal.



Combined differential gain of PAL Vectorscope and Type 141A Generator. Each minor scale division equals ½% differential gain. Top trace 87½% APL, middle trace 50% APL, bottom trace 12½% APL.



Combined differential phase of PAL Vectorscope and Type 141A Generator. Left trace 12½% APL, right trace 87½% APL.

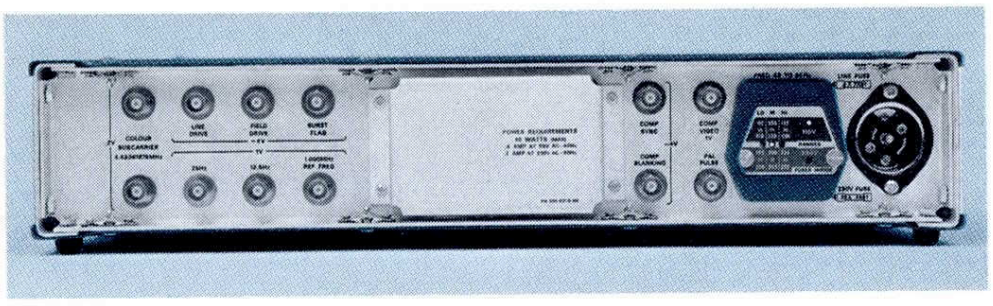
SUBCARRIER ENVELOPE—Risetime is 260 ns within 15% and duration is 39 μs within 5%.

50% FIXED APL—Each active line carries the modulated staircase signal. APL is 50%.

VARIABLE APL—Staircase signal is on every 4th line and the same line every frame. Luminance level range is 700 mV in 10 equal increments, within 2%. The 90°/270° subcarrier modulation on the variable APL lines is 30 mV within 20 %.

VERTICAL INSERTION TEST SIGNAL

The staircase signal may be keyed on during a selected line of the vertical blanking interval, either or both fields (line 11-22 on Field 1 and line 324-335 on Field 2).



SYNC GENERATOR

SUBCARRIER—Frequency is 4.43361875 MHz within 5 Hz.
Outputs—Three outputs (one front panel and two rear panel). Output impedance is 75 Ω within 5%. Output level is 2 V P-P within 0.2 V. Output frequency is unaffected by position of 25-Hz offset switch on front panel.

COMPOSITE SYNC—Two outputs (one front panel and one rear panel). Output level is 4 V within 0.2 V.

COMPOSITE BLANKING—One output (rear panel). Output level is 4 V within 0.2 V.

PAL PULSE—Two outputs (one front, one rear panel). Amplitude and phasing are internally selected to be either of the following: 1) Squarewave—1 V P-P within 0.05 V with transitions occurring with each horizontal sync pulse. Either positive or negative transition is coincident with leading edge of line sync pulse with 135° or 225° burst phasing, (as internally selected). 2) Pulse—4 V P-P within 0.2 V, duration 4.7 μs within 0.2 μs with negative transition coincident with leading edge of line sync pulse on lines with 135° or 225° burst phasing, (as internally selected).

LINE DRIVE—One output (on rear panel). Output level is 4 V within 0.2 V. Risetime is 260 ns within 15%.

FIELD DRIVE—Two outputs (one front panel, one rear panel). Output level is 4 V within 0.2 V. Risetime is 260 ns within 15%.

1-MHz REFERENCE FREQUENCY—One rear-panel output. Frequency is 1.000000 MHz when subcarrier is 4.43361875 MHz with 25-Hz offset. Amplitude is 1 V P-P within 0.2 V.

BURST FLAG—4 V within 0.4 V into 75 Ω. Duration is 2.2 μs within 5%, return loss is at least 30 dB. Delay from horizontal sync is 5.5 μs within 5%.

25 Hz—One rear-panel output. Ouput level is 1 V within 0.2 V.

12.5 Hz—One rear-panel output. Output level is 1 V within 0.2 V.

LINE PERIOD—64 μs (derived from PAL subcarrier frequency).

BURST—Half amplitude duration of envelope is 2.2 μs within 5% (approximately 10 cycles). Burst delay is 5.5 μs within 0.2 μs. Burst component is 300 mV P-P within 3%. V component is 212 mV P-P within 3%. U component is 212 mV within 3%. Amplitude ratio of U/V is 1.00 within 1%. Amplitude on successive lines—smaller is between 97% and 100% of the larger. Phasing—135° within 1° and 225° within 1° on successive lines. Phasing between successive bursts is 90° within 1°.

LINE BLANKING—11.8 μs to 12.3 μs.

FRONT PORCH—1.8 μs within 5%.

LINE SYNC PULSE—Width is 4.7 μs within 0.2 μs; risetime is 230 ns to 290 ns.

FIELD PERIOD—20 ms (digitally derived from 4.43361875 MHz).

FIELD BLANKING—25 lines, 1600 μs (digitally derived from 4.43361875 MHz).

EQUALIZATION PULSE SEQUENCE DURATION—First sequence, 2.5 H (lines); second sequence, 2.5 H (lines).

FIELD SYNC PULSE—Sequence duration is 2.5 H (lines); pulse duration is 27.3 μs within 0.2 μs.

INTERVAL BETWEEN FIELD SYNC PULSES—47 μs within 0.2 μs.

NOTE:
All amplitudes are specified with 75-Ω load impedance. Return loss (where applicable) is always greater than 30 dB. Isolation between all outputs is always greater than 40 dB.

All connectors are BNC type.

OTHER CHARACTERISTICS

COMPOSITE VIDEO OUTPUT

Two outputs are provided through BNC type connectors, one front panel and one rear panel. Composite video consists of composite sync and video test signals as selected by front-panel controls. Amplitude is 1 V P-P into 75 Ω. Return loss is at least 30 dB.

POWER REQUIREMENTS

90 to 136 VAC or 180 to 272 VAC, 48 Hz to 66 Hz. 55 W max at 230 VAC, 50 Hz. A rear-panel selector provides accommodation for 6 line voltage ranges.

AMBIENT TEMPERATURE—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C (except as noted).

DIMENSIONS AND WEIGHTS

Type 141A	Height	3½ in	8.9 cm
	Width	16¾ in	42.6 cm
	Depth	18½ in	47.7 cm
	Net weight	17¾ lb	8.0 kg
Type R141A	Height	3½ in	8.9 kg
	Width	19 in	48.3 cm
	Depth	18¼ in	47.7 cm
	Net weight	18½ lb	8.4 kg

INCLUDED STANDARD ACCESSORIES

75-Ω through-line termination (011-0103-02); 7½ foot 3-wire power cord (161-0036-00); 2 instruction manuals (070-1008-00). Type R141A also includes rackmounting hardware.

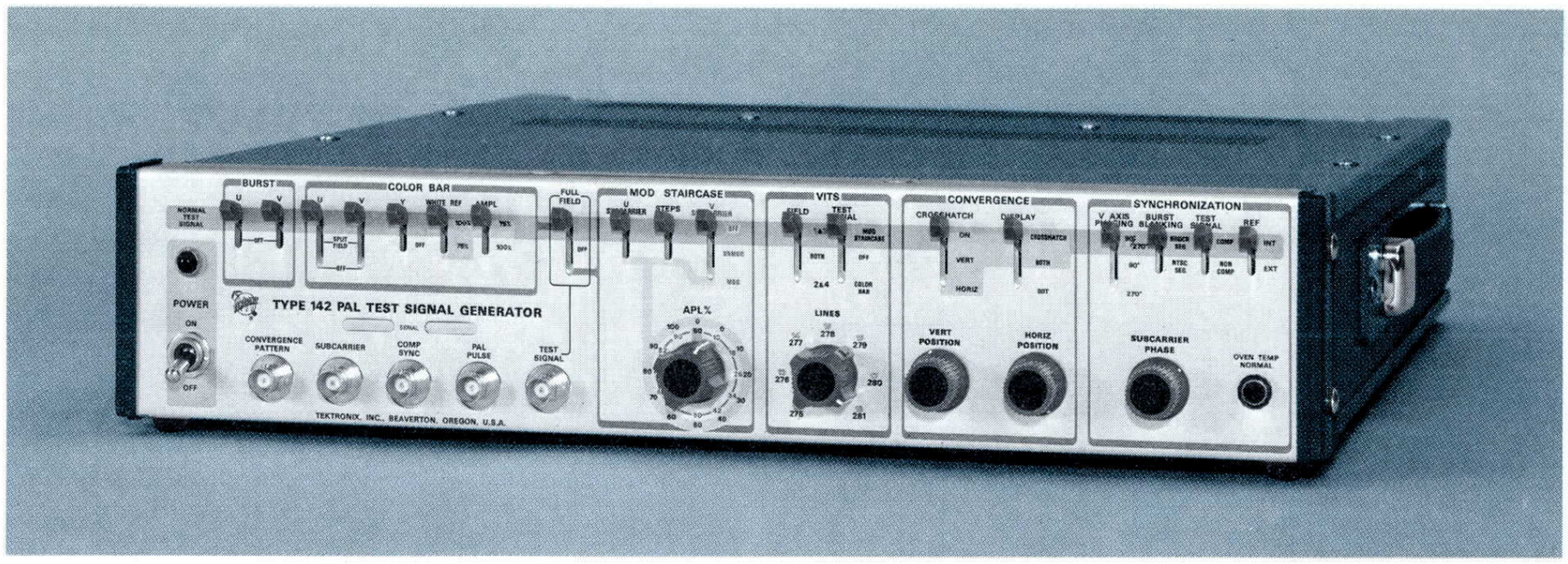
TYPE 141A PAL TELEVISION TEST SIGNAL GENERATOR $1800

TYPE R141A PAL TELEVISION TEST SIGNAL GENERATOR $1800

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

NEW

142 PAL TV Signal Generator R142



- ***525-LINE, 60-CYCLE FIELD, 3.575611 MHz SUBCARRIER***
- ***PAL COLOR BARS—FULL FIELD or SPLIT-FIELD EBU bars—75% amplitude, 100% saturated,***

  50 mV setup, 100% white reference (75% white reference alternatively selectable)

  100% bars—100% amplitude, 100% saturated, 50 mV setup, 100% white reference
- ***MODULATED 5-STEP STAIRCASE Fixed or variable APL***
- ***VERTICAL INSERTION TEST SIGNAL Modulated staircase or color bars, lines 275 through 281 fields 2 and 4, lines 12 through 18 fields 1 and 3, or both pairs***
- ***CONVERGENCE CROSSHATCH For color picture monitor convergence adjustment For camera and picture monitor linearity, geometry, and aspect ratio measurements***
- ***PAL SYNC GENERATOR***

The Type 142 PAL Test Signal Generator is a source of high-quality television test signals for 525-line, 60-cycle field PAL color TV systems. The all solid-state Type 142 utilizes digital integrated circuits to achieve stability, accuracy and reliabity. The self-contained sync generator includes a temperature controlled color standard with excellent frequency stability.

Three operating modes provide PAL Color Bars, a 5-Step Staircase with fixed Average Picture Level (APL), Staircase with variable APL, with a convergence pattern on separate output. The standard color bar output is a full-field test signal appearing on every active line and consists of 75% or 100% amplitude color bars in descending luminance order with 50 mV setup. With 75% amplitude the white reference can be selected for 75% or 100% levels. The combination of 75% amplitude bars and 100% white reference is known as EBU bars (European Broadcast Union). When the U and V switches are both in the SPLIT FIELD position, the chrominance signals are not present during the last 60 lines per field. Viewed on a color monitor, the color bar is a split field display, the bottom portion being in monochrome. Any component of the composite video signal may be turned off. This includes U, V, Y, the entire color bar signal, sync, burst (either U or V component or both).

The staircase signal is particularly useful with a Tektronix Type 522 Vectorscope to measure differential phase and differential gain. Luminance channel linearity may also be measured using the Tektronix video staircase differentiator part #015-0075-00 (the transient response of the staircase signal component is determined by a $\sin^2$ filter whose cut-off frequency limits the energy content in the region of the color subcarrier frequency).

The PAL subcarrier (140 mV P-P) is accurately phased at 0° (it lies along the +U PAL axis and is at the same phase on alternate lines). Subcarrier may be switched off when desired. The last step (at white level) is double width so it can be viewed with and without subcarrier to detect clipping in the white direction.

To provide VITS (Vertical Insertion Test Signal) information, the staircase or color bar signal is keyed on during a selected line of the vertical blanking interval in one or both pairs of fields, depending on the settings of the Field and Line switches.

Normal PAL color burst is provided on the staircase and color bar signals. The complex four-field burst blanking sequence during vertical interval is provided and may be switched off if desired.

The Type 142 can serve as a PAL sync generator. It provides composite blanking and composite sync outputs, line and field drive pulses and PAL V axis switching pulses. It may be synchronized with the following timing signals from another PAL sync generator: subcarrier CW, composite sync and PAL pulses. The Type 142 cannot be gen-locked by the PAL composite video signal.

The Type 142 is available in either rackmount (R142) or cabinet (142) styles.

NEW

142 PAL TV Signal Generator R142

COLOR BARS

LUMINANCE AND CHROMINANCE AMPLITUDE ACCURACIES—(25°C reference). Absolute amplitudes of luminance signal, setup and sync are within 1% or 1.5 mV, whichever is greater. Absolute amplitudes of all subcarrier frequency components (chrominance, U and V) are within 3%. Relative amplitudes of all subcarrier frequency components, as referred to the red bar, are within 1% or 1.5 mV, whichever is greater.

BAR WIDTH—6.6 μs within 5%.

WHITE REFERENCE—100% amplitude (normal), 75% amplitude.

CHROMINANCE—Time difference between luminance and chrominance channels is 20 ns or less. Risetime is 375 ns within 15%. U, V quadrature error is 0.5° or less, V axis phase switcher error is 0.5° or less.

RESIDUAL SUBCARRIER—At least 52 dB below 1 V on white, or black.

ABERRATIONS—Within 4% of 1 V P-P.

SPURIOUS SUBCARRIER—At least 52 dB below 1 V when viewed on a Type 529 Waveform Monitor. Other spurious outputs are at least 52 dB below 1 V also.

MODULATED STAIRCASE

LUMINANCE COMPONENT—5-step amplitude is 700 mV within 1%. Single step amplitude is 140 mV within 1%. Step risetime is 260 ns within 15%. Step duration at blanking level is 13.3 μs within 5%. Intermediate step duration is 6.6 μs within 5%. Aberrations are within 2% of step amplitude.

CHROMINANCE COMPONENT—Amplitude is 140 mV P-P within 3%. Phase is 0°.

DIFFERENTIAL PHASE—0.1° or less.

DIFFERENTIAL GAIN—0.5% or less at 10%, 50%, 90% APL.

SUBCARRIER ENVELOPE—Risetime is 375 ns within 15% and duration is 39 μs within 5%.

APL 50%—When the 50% position for a normal test signal is selected, each active line carries the modulated staircase signal. APL is 50%. The V subcarrier switch is inactive in this position.

VARIABLE APL (STEPS switch ON)—Four out of five active lines carry the luminance pedestal. The staircase signal will appear on every fifth active line and any VIT line. Under these conditions the APL range is 10-90%. This is shown in red numbers in 8% increments. The V subcarrier switch is active.

VARIABLE APL (STEPS switch OFF)—With the U subcarrier switch OFF, the luminance pedestal is on every active line, and the VIT line when the VITS is the staircase signal. Under these conditions, the APL range is 0-100%. This is shown in black numbers in 10% increments. The V subcarrier switch is active.

SUBCARRIER COMPONENT (UNMOD)—30 mV within 1.5 mV during active line time of 52.3 μs.

SUBCARRIER COMPONENT (MOD)—30 mV within 1.5 mV for the first and last 13.1 μs of active line time, 300 mV within 3% for the second 13.1 μs, and 600 mV within 3% for the third 13.1 μs. Incidental phase errors between 30 mV, 300 mV, and 600 mV signals 0.5° or less. See Fig 9.

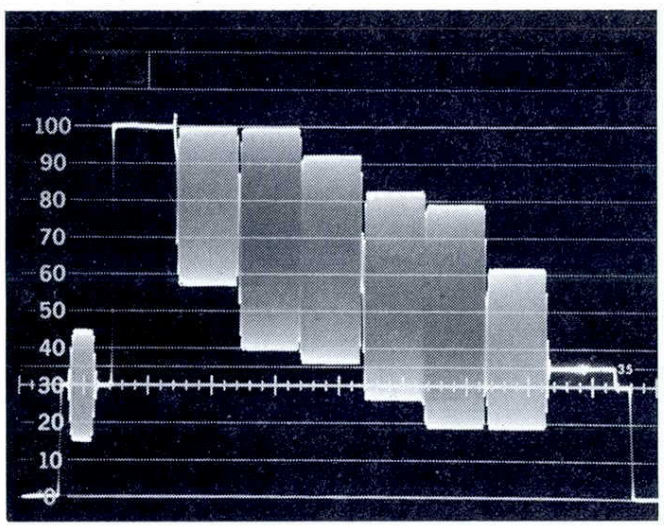


Fig 1: Full field color bars, 75% amplitude, 100% white reference.

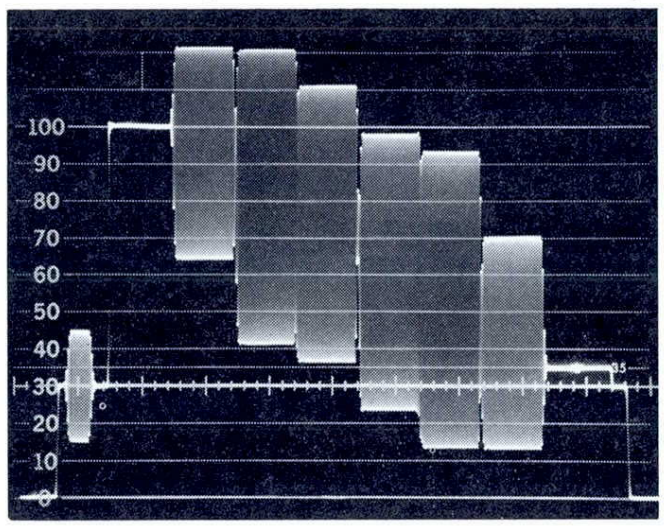


Fig 2: Full field color bars, 100% amplitude.

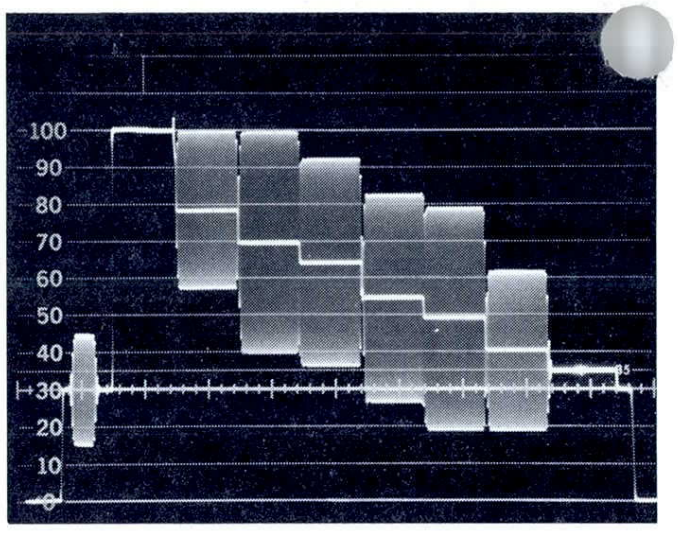


Fig 3: Split field color bars, 75% color bars at 100% saturation for ¾ of each field and luminance component only for last ¼. Useful for grey scale check of picture monitors.

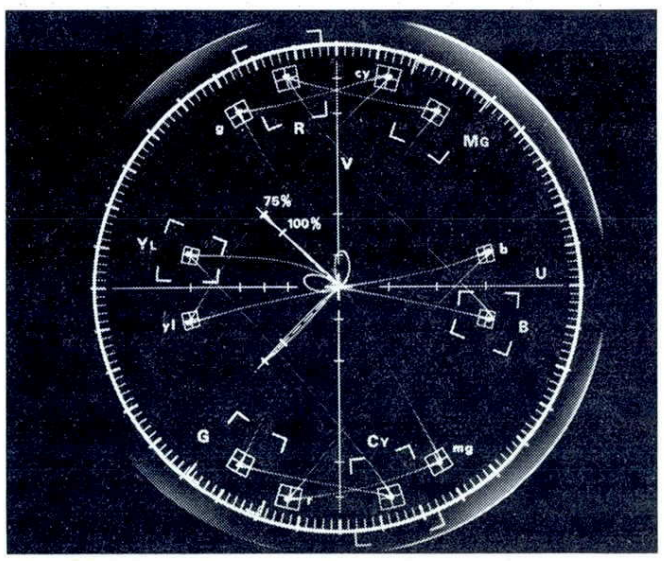


Fig 4: Vector PAL presentation of PAL color bar signal using Type 522 Vectorscope. Note clean vector transients.

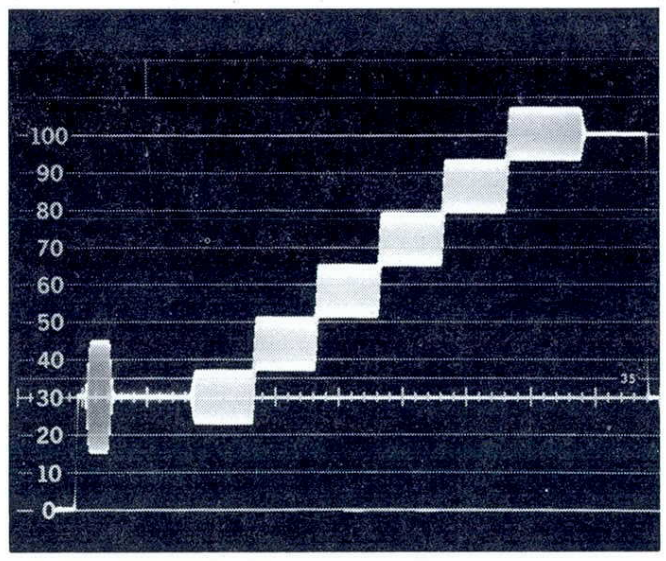


Fig 5: Modulated staircase test signal, subcarrier phased to U axis (peak white reference provided). APL is 50%.

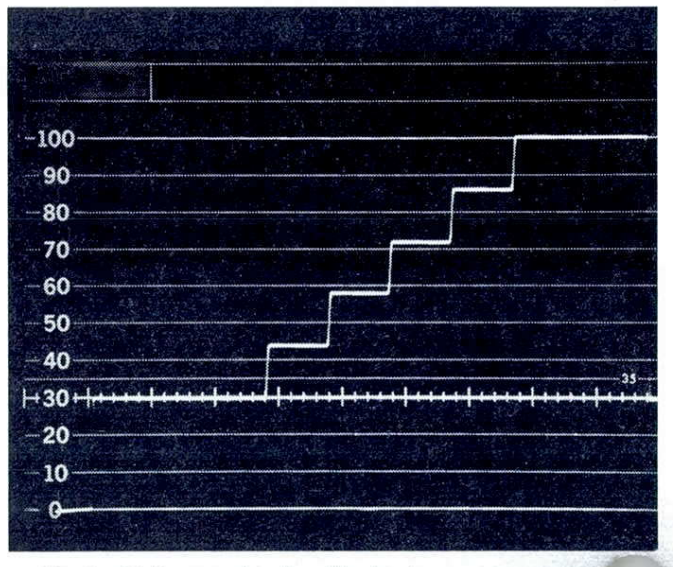


Fig 6: Staircase signal with luminance component. Identical transitions of 260 ns risetime may be differentiated to measure luminance channel amplitude linearity.

NEW

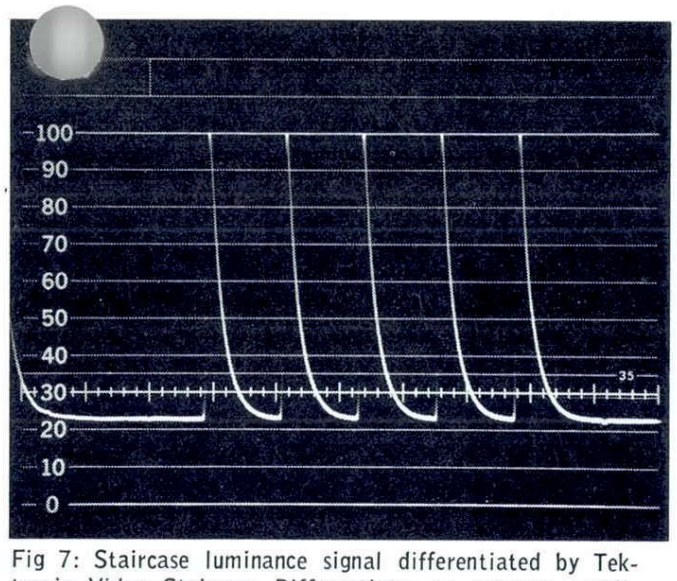


Fig 7: Staircase luminance signal differentiated by Tektronix Video Staircase Differentiator to measure amplitude non-linearity. Identical height of each pulse indicates lack of distortion in the test signal.

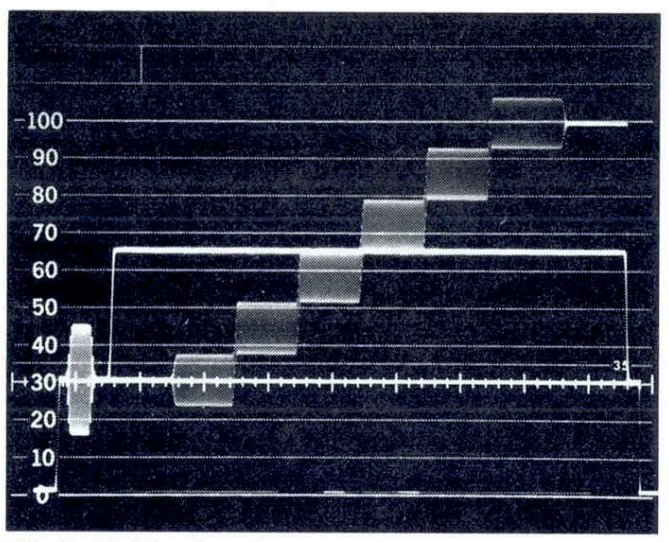


Fig 8: Modulated staircase signal with variable APL. Every fifth active line carries staircase, others have luminance pedestal variable from blanking to peak white.

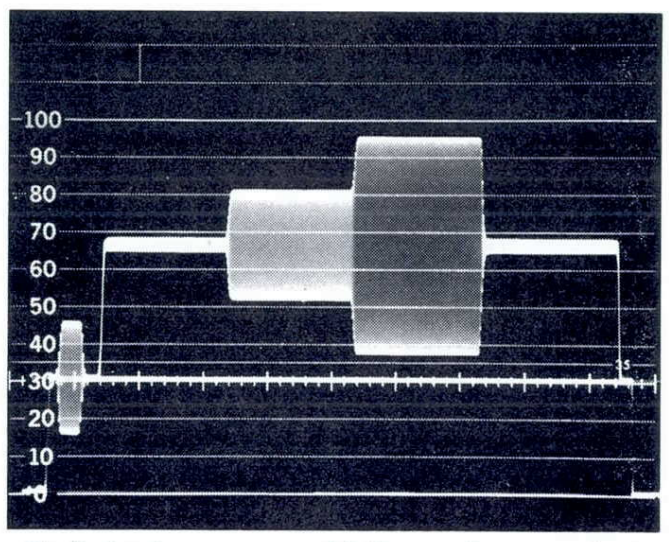


Fig 9: Luminance cross modulation may be measured with this component of the staircase test signal. Subcarrier is on the V axis, amplitudes are 30 mV, 300 mV and 600 mV.

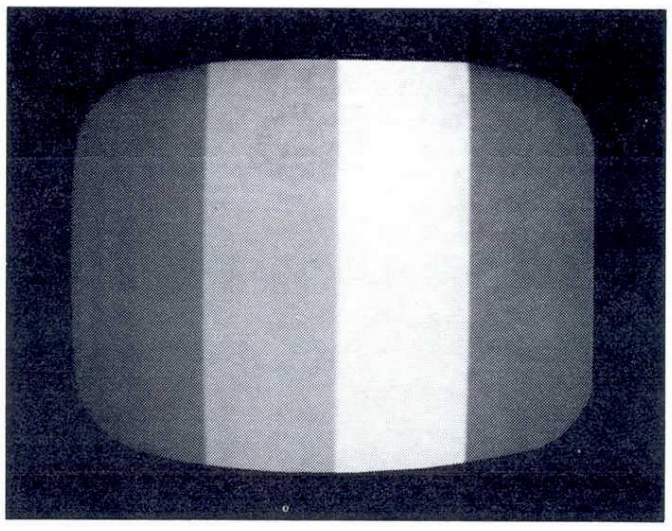


Fig 10: Picture monitor display of test signal shown in Fig 9. Luminance cross modulation causes changes in brightness on a monochrome monitor. When applied to a color monitor it can be used to phase decoders by observing the blue gun only.

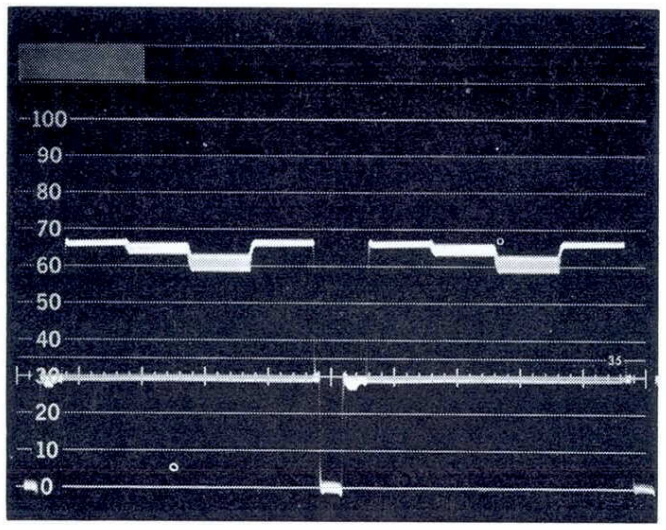


Fig 11: Luminance cross modulation occurring in a Nyquist type demodulator.

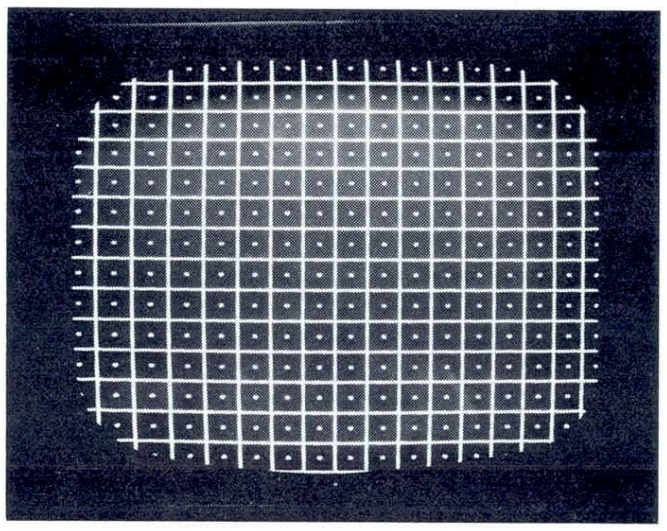


Fig 12: Convergence pattern, suitable for convergence, scanning linearity, and aspect ratio adjustments of monitors.

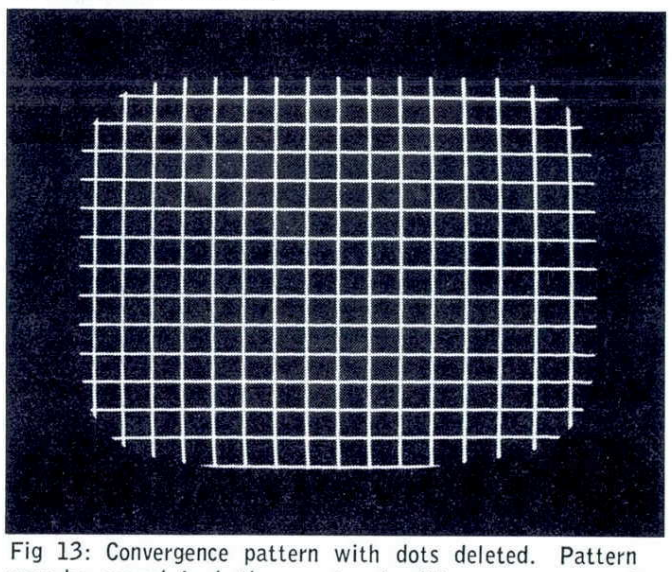


Fig 13: Convergence pattern with dots deleted. Pattern may be moved in both axes to simplify measurement of camera or monitor linearity using EIA Linearity Chart 1961.

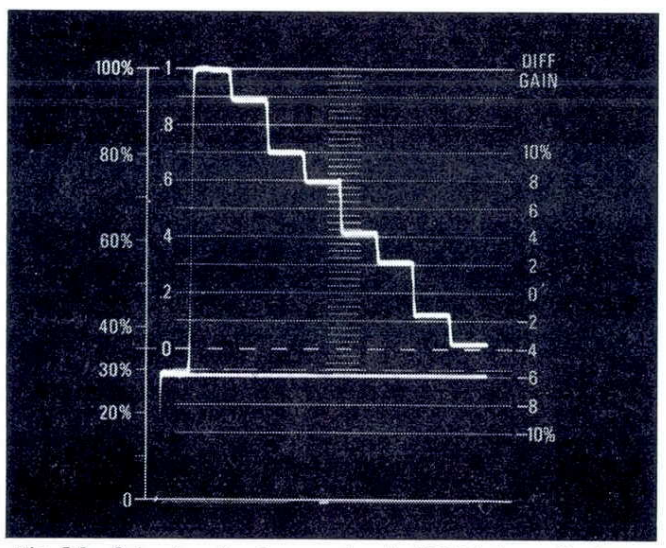


Fig 14: Color bar luminance signal, 100% bars displayed on Type 522 Vectorscope.

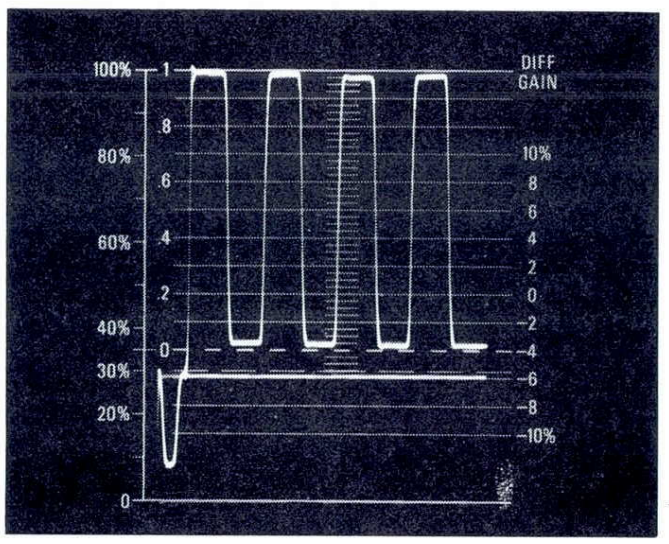


Fig 15: Decoded blue signal, 100% amplitude color bar displayed on Type 522 Vectorscope.

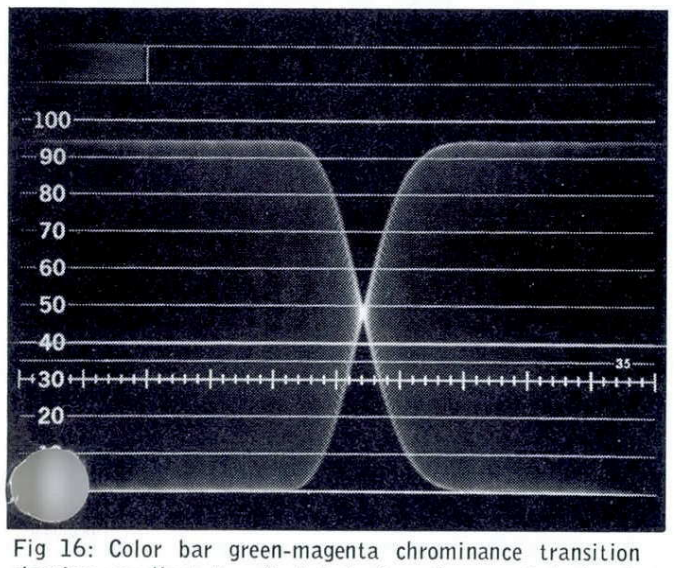


Fig 16: Color bar green-magenta chrominance transition showing excellent transient behavior of generated signal.

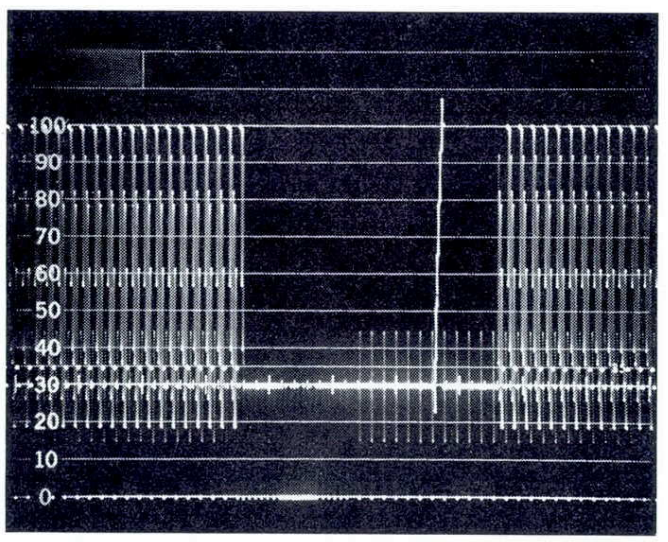


Fig 17: Either the staircase or the color bar signal may be inserted by the Type 142 on a selected line of the vertical blanking interval.

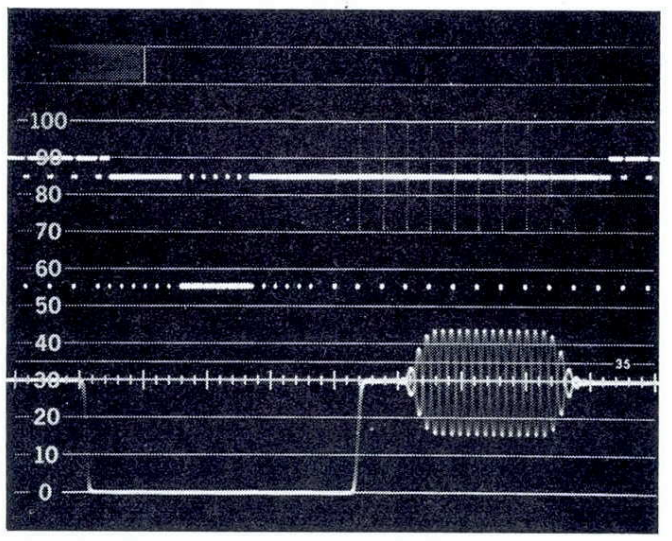


Fig 18: PAL sync signal. Standard broadcast quality sync, blanking, PAL burst blanking, and color burst as generated by the Type 142.

NEW

142 PAL TV Signal Generator R142

VERTICAL INSERTION TEST SIGNAL

A provision is made for insertion of either the staircase or the color bar, as a vertical insertion test signal, on lines 275 through 281 fields 2 and 4, or on lines 12 through 18 fields 1 and 3, or on both pair of fields. The phase of the burst may be varied 360° with respect to the subcarrier frequency source (internal or external).

SYNC GENERATOR AND COLOR STANDARD

SUBCARRIER—Frequency is 3.575611 MHz within 5 Hz.
Outputs—2 outputs (BNC type connectors, 1 front and 1 rear panel). Output impedance is 75 Ω. Isolation is 40 dB and return loss is at least 30 dB. Output level is 2 V P-P within 0.2 V into 75 Ω.
*Input—Subcarrier input requires at least 1 V P-P. The return loss is at least 46 dB using loop-through input.

COMPOSITE SYNC
Output—A front-panel and a rear-panel output is provided. Output level is 4 V within 0.2 V. Return loss is at least 30 dB to 5 MHz. Isolation is at least 40 dB.
*Input—Required amplitude is at least 2 V P-P. Return loss is at least 46 dB using loop-through input.

PAL PULSE—Amplitude and phasing are internally selected and independent of front-panel V AXIS PHASING switch.
Output—A front-panel and a rear-panel output provide a negative pulse of 4 V within 0.2 V into 75 Ω. Duration is 4.7 μs within 0.2 μs, rise and falltime is 115 ns within 15%. Negative transition is coincident with leading edge of line sync pulse on lines with 135° or 225° (internally selected) burst phasing. Return loss is at least 30 dB, isolation is at least 40 dB.
*Input—Required amplitude is at least 2 V P-P. Return loss is at least 46 dB using loop-through input.

TEST SIGNAL—Two outputs are provided through BNC type connectors, one front panel and one rear panel. The test signal consists of composite sync and video test signals as selected by front-panel controls. Amplitude is 1 V P-P into 75 Ω. Return loss is at least 30 dB. Isolation is 40 dB.

COMPOSITE BLANKING—One rear-panel output is provided through a BNC type connector. Output level is 4 V within 0.2 V. Return loss is at least 30 dB. Risetime is 115 ns.

VERTICAL DRIVE—4 V within 0.2 V into 75 Ω, one rear panel output. Return loss is at least 30 dB. Risetime is 115 ns.

HORIZONTAL DRIVE—4 V within 0.2 V into 75 Ω, one rear panel output. Return loss is at least 30 dB. Risetime is 115 ns.

BURST FLAG—4 V within 0.2 V into 75 Ω. Duration is 2.3 μs within 5%, return loss is at least 30 dB. Delay from horizontal sync is 5.0 μs within 5%. Risetime is 115 ns.

CONVERGENCE PATTERN—One front panel and one rear panel output provide a 1 V composite video signal, consisting of composite sync and convergence pattern signals as selected by the front-panel controls. Return loss is 30 dB. Isolation is 40 dB.

*Inputs are optional and only required for synchronizing with another PAL sync generator.

LINE PERIOD—63.5 μs (digitally determined from 3.57[illegible] MHz).

BURST—Half amplitude duration of envelope is 2.22 to 2.61 μs (approximately 10 cycles). Breezeway is at least 379 ns. Burst component is 300 mV P-P within 3%. V Component is 212 mV P-P within 3%. U component is 212 mV P-P within 3%. Amplitude ratio of U/V is 1.00 within 1%. Amplitude on successive lines—smaller is between 97% and 100% of the larger. Phasing—135° within 1° and 225° within 1° on successive lines. Phasing between successive bursts is 90° within 1°.

LINE BLANKING—11.1 μs (digitally determined from 3.575611 MHz).

FRONT PORCH—1.54 μs within 0.05 μs measured at 10% from blanking.

LINE SYNC PULSE—Width is 4.71 μs within 0.05 μs, rise and falltime is 115 ns within 10%.

FIELD BLANKING—21 lines, 1334 μs (digitally determined from 3.575611 MHz).

EQUALIZATION PULSE SEQUENCE DURATION—First and second sequence 3H (6 pulses).

FIELD SYNC PULSE DURATION—27.3 μs within 0.2 μs.

INTERVAL BETWEEN FIELD SYNC PULSES—4.5 μs within 0.2 μs.

OTHER CHARACTERISTICS

POWER REQUIREMENTS
90 to 136 VAC or 180 to 272 VAC, 48 Hz to 66 Hz. 55 W max at 230 VAC, 50 Hz. A rear-panel selector provides accommodation for 6 line voltage ranges.

AMBIENT TEMPERATURE—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C (except as noted).

DIMENSIONS AND WEIGHTS

Type 142	Height	3½ in	8.9 cm
	Width	16¾ in	42.6 cm
	Depth	18½ in	47.7 cm
	Net weight	17¾ lb	8.0 kg
Type R142	Height	3½ in	8.9 cm
	Width	19 in	48.3 cm
	Depth	18¼ in	47.7 cm
	Net weight	18½ lb	8.4 kg

INCLUDED STANDARD ACCESSORIES
75-Ω through-line termination (011-0103-02); 7½ foot 3-wire power cord (161-0036-00); 2 instruction manuals (070-1031-00). Type R142 also includes rackmounting hardware (351-0195-00).

TYPE 142 PAL TELEVISION TEST SIGNAL GENERATOR $2000

TYPE R142 PAL TELEVISION TEST SIGNAL GENERATOR $2000

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Special-Purpose Instruments

Products in this group have those features required to meet particular measurement requirements. Some features found in general-purpose instruments are omitted in favor of those features required for these specialized applications.

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CURVE TRACER REFERENCE 326

576 SEMICONDUCTOR CURVE TRACER 327
Provides 6½-inch display of semiconductor characteristics

575 SEMICONDUCTOR CURVE TRACER 332
Provides 5-inch display of semiconductor characteristics

175 HIGH-CURRENT ADAPTER 336
Allows plotting of high-current curves on 575

PHYSIOLOGICAL MONITOR REFERENCE 338

410 PHYSIOLOGICAL MONITOR 340
Displays ECG, EEG, other physiological phenomena

ENGINE ANALYZER REFERENCE 344

ENGINE ANALYZERS 345
Display performance of gas and diesel engines

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Displays fractional-nanosecond events

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Indicates unknown inductance or capacitance

Curve Tracer Reference

Some oscilloscopes are specially designed for displaying semiconductor parameters. Known as curve tracers, these oscilloscopes are capable of displaying one or more characteristic curves of two and three-terminal devices. Each curve is developed by driving one terminal with a constant voltage or current and then sweeping the other with a half sinewave of voltage. If more than one curve is to be drawn, the driving source is stepped through several values and the sweep repeated, once for each step. The horizontal deflection is then a plot of either the driving voltage or the sweep voltage across the device under test, while the vertical deflection is a plot of the current drawn from the sweep source.

The reasons for measuring the characteristics of semiconductor devices are varied. Typical measurements are for the purpose of producing better components, sorting components, predicting performance in a circuit, or simply checking to see if the device meets specs. The characteristics of semiconductor devices that are of practical importance to their use in an electrical circuit can usually be measured with a curve tracer. Many of those measurements also provide good analytical information for people improving component design or maintaining production quality and specifications.

Tektronix offers two curve tracer models: the Type 576 and the Type 575. The charts below, along with the detailed specifications of each on the next 11 pages, should assist you in selecting the right one for your requirements.

576 MEASUREMENT CAPABILITIES

DEVICE	FEATURES
DIODES	1 nA/div sensitivity for leakage measurements—1500-V collector supply—Kelvin sensing for accurate high-current measurements.
FET's	40 V (step + offset) available for base drive—Step offset allows stepping through zero bias—1 nA/div sensitivity measures gate leakage—AC sweep allows examination of resistive region.
SCR's	Calibrated variable step offset accurately determines gate firing potential—Holding current may be read directly.
POWER TRANSISTORS	Kelvin sensing for accurate high-current measurements—Pulsed base allows high-current beta measurements without exceeding dissipation limits or requiring heat sinks.
TRANSISTORS	EXTENDED RANGES ON ALL TRANSISTOR MEASUREMENTS—Small steps on top of an offset (as much as 100X the step amplitude) permit observation of several voltage-driven steps within the active region. Auto positioning of PNP and NPN displays.
TUNNEL DIODES	AC sweep displays forward and reverse characteristics simultaneously.
ZENERS	High-resolution 2% voltage measurements of the zener region are possible with the use of the CALIBRATED DISPLAY OFFSET and MAGNIFIER.

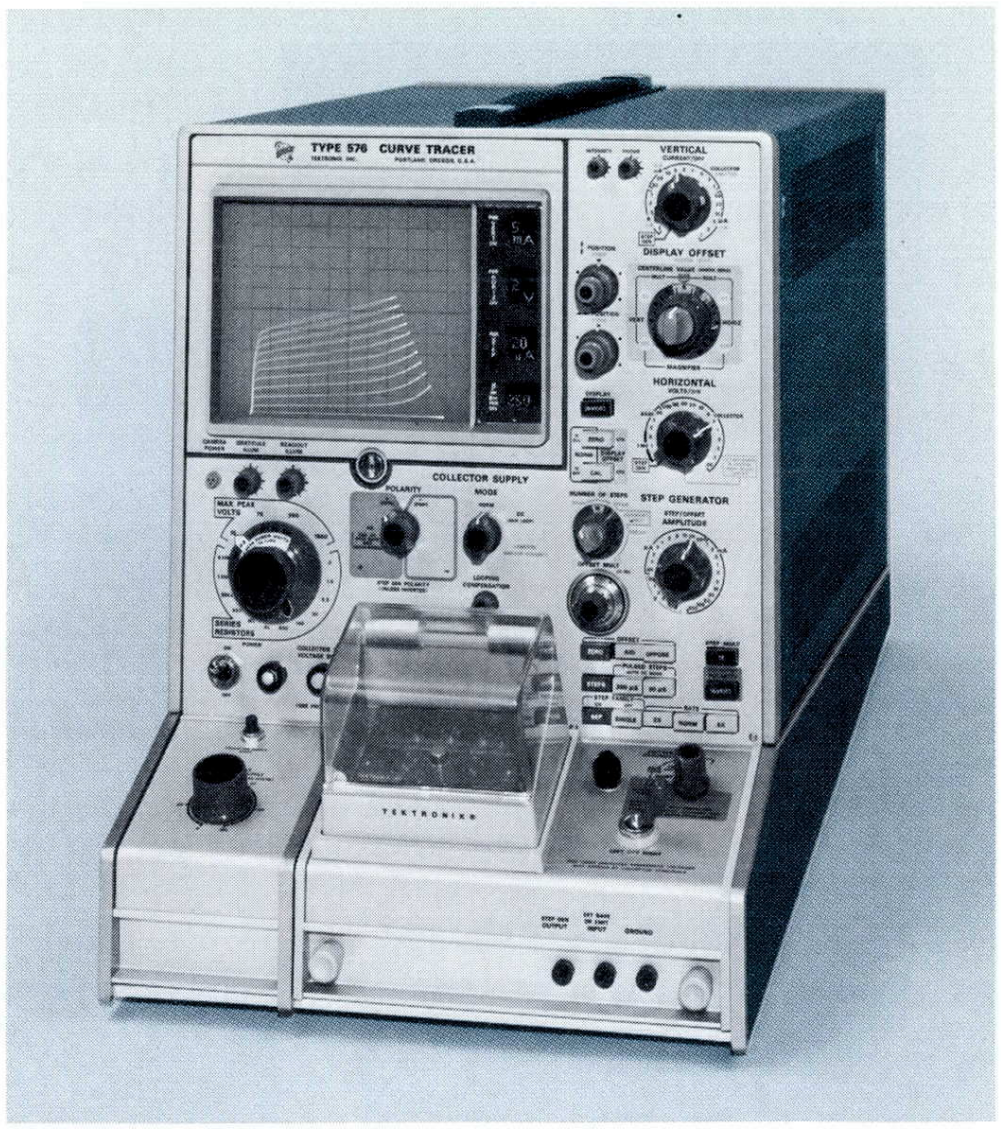
575 MEASUREMENT CAPABILITIES

DEVICE	FEATURES
DIODES	200 V collector supply. MOD 122C has 1500 V.
POWER TRANSISTORS	Collector supply is extended to 200 A with the TYPE 175 HIGH-CURRENT ADAPTER.
TRANSISTORS	Supplies for checking PNP and NPN types.
TUNNEL DIODES	Forward and reverse characteristics can be alternately displayed by manually changing collector supply polarity.
ZENERS	Voltage measurements of zener region with reasonable resolution.

Semiconductor Curve Tracer

576

- ***BIG 6½-INCH CRT***
- ***AUTO SCALE FACTOR READOUT including β/div or g_m/div***
- ***THREE COLLECTOR SUPPLY MODES***
- ***AUTO POSITIONING AND POLARITY TRACKING***
- ***PULSED BASE OPERATION***
- ***CALIBRATED DISPLAY OFFSET WITH MAGNIFIER***
- ***KELVIN SENSING ADAPTERS FOR HIGH CURRENT TESTS***
- ***PROTECTIVE FEATURES FOR OPERATOR AND DEVICE***



The Type 576 brings meaningful performance to semiconductor testing and establishes a new standard in human engineering features. The measurement requirements for diodes, transistors, and FET's (in all their different forms) established the functions of the Type 576; innovative circuit and component engineering make those measurements easy, accurate, safe and more understandable.

The most noticeable new feature is AUTO SCALE-FACTOR READOUT. Placed adjacent to the CRT (where you normally focus your attention) are digital indicators of vertical and horizontal deflection factors, step amplitude, and Beta/div or g_m/div. Readout offers convenience for test setup and labeled waveform photography. It also offers freedom from the simple but bothersome arithmetic required to compute Beta/div or g_m/div or to correct for magnifiers or multipliers. The other features, such as multifunction switching, calibrated display offset, and many more, are equally important to semiconductor testing applications. The following page describes these features around waveform photographs of measurement situations.

CHARACTERISTIC SUMMARY

CRT & READOUT

CRT—6½-inch rectangular; 10 cm x 10 cm calibrated area, 4 kV, P31 phosphor.

READOUT—digital indicators of VERT CURRENT/div, HORIZ VOLTS/div, CURRENT or VOLTS per STEP, and BETA/div or g_m/div.

COLLECTOR SUPPLY

VOLTAGE RANGE—0 V to 1500 V, continuously variable.

POLARITY—positive, negative, or AC.

PEAK CURRENT—10 A to 0.1 A; doubled in pulse mode.

POWER LIMIT SETTING—0.1 W (or less) to 220 W in 6 steps.

STEP GENERATOR

CURRENT STEPS—5 nA/step (0.1X MULT) to 200 mA/step; 2 A max.

VOLTAGE STEPS—5 mV/step (0.1X MULT) to 2 V/step; 40 V max including offset.

CALIBRATED STEP OFFSET—0 to X10 the step amplitude setting, AID or OPPOSE.

NUMBER OF STEPS—0 to 10, digitally selectable.

PULSED STEPS—300 μs or 80 μs pulse width.

VERTICAL AND HORIZONTAL AMPLIFIERS

VERT COLLECTOR CURRENT—0.1 μA/div (X10 MAG) to 2 A/div.

VERT EMITTER CURRENT—1 nA/div to 2 mA/div.

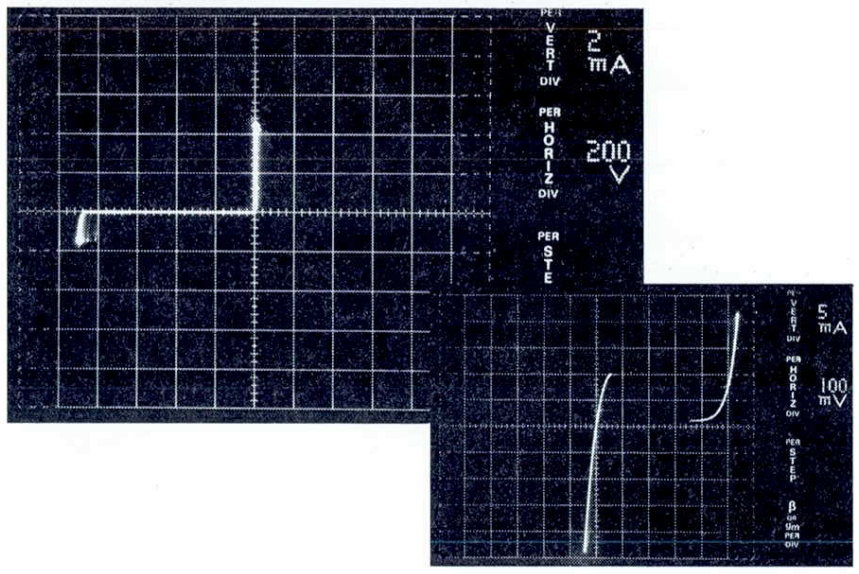
HORIZ COLLECTOR VOLTS—5 mV (X10 MAG) to 200 V/div.

HORIZ BASE VOLTS—5 mV/div (X10 MAG) to 2 V/div.

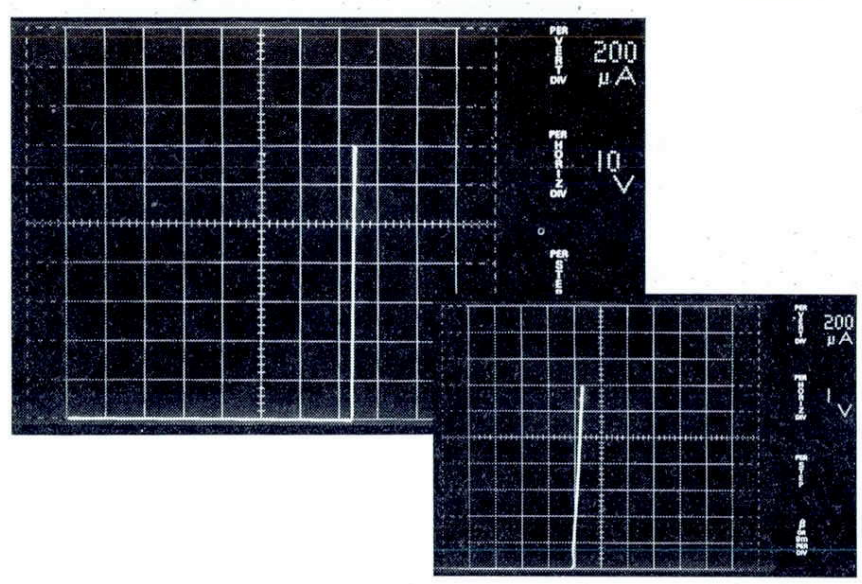
DISPLAY OFFSET AND MAGNIFIER—X10 MAG with calibrated positioning increases resolution and accuracy.

How the TYPE 576 Makes the Measurement . . . Easier

DIODES

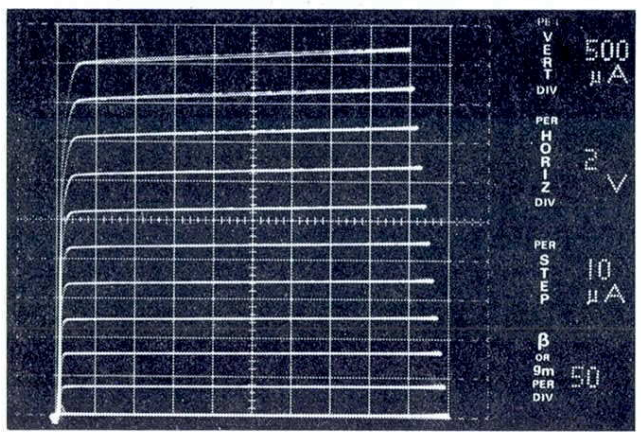


This test shows reverse breakdown and forward current characteristics simultaneously. The AC mode (+ and — collector sweep) was selected, which automatically positioned the trace to center-screen. The power limit (0.1 W) was selected with the direct-reading switch. The operator was protected from shock by the protective box, which disconnects voltage to the device when the cover is raised. The inserted waveform shows the forward and reverse characteristics of a tunnel diode. Identical functions were used except at different settings.

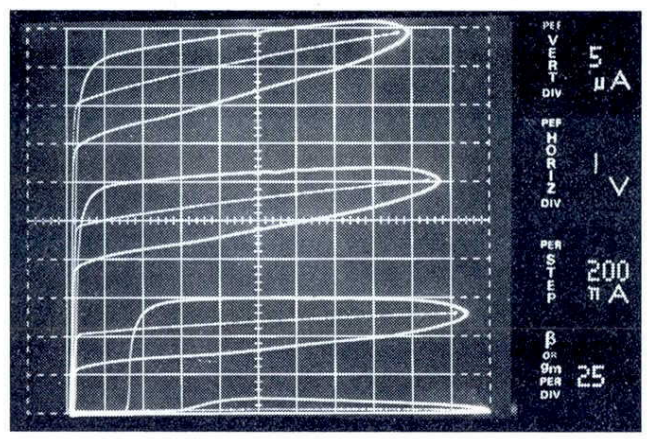


This display of a zener diode test demonstrates the use of the CALIBRATED DISPLAY OFFSET and MAGNIFIER to increase resolution. The main waveform shows the zener region to be somewhere above 73 V. With the DISPLAY OFFSET and MAG, the trace was centered, positioned horizontally exactly 7.5 divisions, and magnified 10 times (see insert). The center graticule line is now a known 75 V with the horizontal scale at 1 V/div. The zener voltage at 1 mA can now be measured at 74.2 V, accurate within 2%.

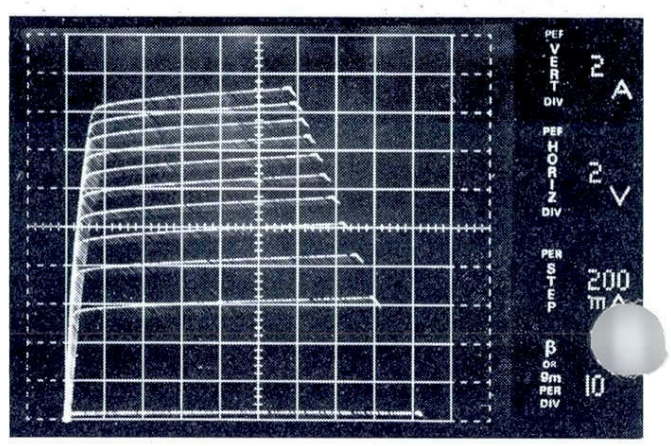
TRANSISTORS



This is an NPN transistor family of curves. When the positive collector supply polarity was selected, the step generator polarity automatically became positive and the trace start was positioned to the proper point. The display shows a full 10-step family but the number of steps could have been digitally selected between 1 and 10. The parameter readout effectively labels the waveform, giving vertical collector current/div, horizontal collector volts/div, current amplitude per step, and computes Beta/div.

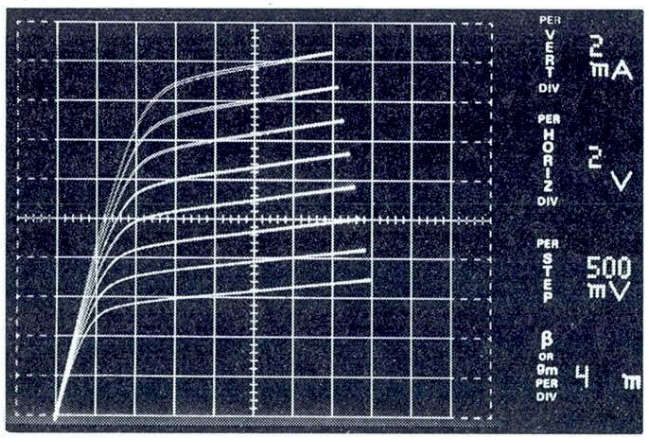


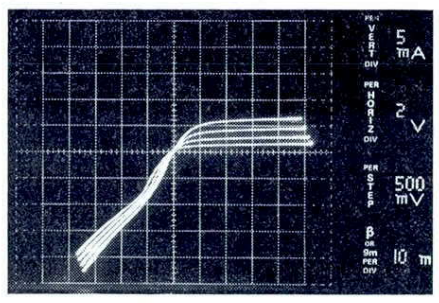
This waveform is a double exposure showing the increased readability for low-current devices obtained by using the DC collector supply mode. The wide "loops" are the result of the collector-to-base capacitance being swept at 120 Hz in the NORM collector supply mode. The center-line (in the middle of each loop) is the display obtained in the DC mode by manually turning the variable voltage control. The DC mode is functional since measurements can be made to 100 nA/div for collector currents, or 1 nA/div in the leakage mode.



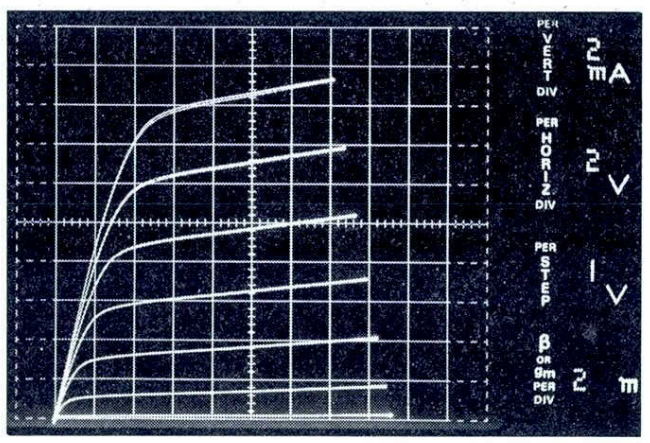
This display is a power transistor test at 17-A collector current with 2 A into the base; Beta/div is shown as 10. Power devices can be checked at 10-A continuous or 20-A peak pulse mode current. Max base current is 2 A. The 80-μs pulsed base mode is used for duty-cycle limiting (300 μs also available) and single family operation offers further control. Collector-emitter voltage can be measured more accurately with the TO-3 and TO-66 adapters which employ KELVIN contacts to cancel the effects of contact resistance.

FET's





The Type 576 is particularly well suited for FET measurements. Here a FET is operating in the enhancement mode (positive drain sweep and voltage steps) with the maximum power and gate current selected and limited for device protection. For operation in the depletion mode, the step generator polarity can be inverted (INVERT switch). The insert shows a FET with AC (positive and negative) drain sweep for inspection of the resistive region characteristics.



This drain family shows FET characteristics in both enhancement and depletion modes, accomplished with the CALIBRATED DC STEP OFFSET. The voltage/step is selectable, the number of steps is digitally selectable between 1 and 10, and the first step can be started from any DC plateau betwe and 10X the amplitude setting, aiding or opposing the step polarity. In case an opposing DC voltage was selected allowing the positive steps to start below the zero bias point.

COLLECTOR SUPPLY

MODES

NORM: positive or negative full wave rectified AC (line frequency).

DC: positive or negative DC. No-load ripple $\leq$2% of voltage or $\leq$0.1% of full range voltage.

LEAKAGE: emitter current rather than collector current measurements with an increase in the basic vertical deflection factor to 1 nA/div.

VOLTAGES

Peak open circuit voltages within +35% and —5% of indicated range.

RANGES	15 V	75 V	350 V	1500 V
MAX CONTINUOUS PEAK CURRENT	10 A	2 A	0.5 V	0.1 A
PEAK PULSE MODE CURRENT	$\geq$20 A	$\geq$4 A	$\geq$1 A	$\geq$0.2 A

SERIES RESISTANCE—from 0.3 Ω to 6.5 MΩ in 12 steps, all within 5% or 0.1 Ω.

PEAK POWER LIMIT

SETTING 0.1 W, 0.5 W, 2.2 W, 10 W, 50 W, 220 W, all within 40%.

SAFETY INTERLOCK

A protective cover over Test Terminals must be closed to apply collector voltage in 75 V, 350 V, and 1500 V ranges.

STEP GENERATOR

ACCURACY

Current or voltage steps including offset.

INCREMENTAL: within 5% between steps; within 10% with 0.1X MULT.

ABSOLUTE: within 2% of total output including offset, or 1% of AMPLITUDE setting, whichever is greater.

OFFSET MULTIPLIER—0 to X10 the AMPLITUDE setting, continuously variable. Polarity AID(s) or OPPOSE(s) the step polarity.

CURRENT MODE

STEP AMPLITUDE RANGE—5 nA/step (with 0.1X MULT) to 200 mA/step, 1-2-5 sequence.

MAX CURRENT (steps and aiding offset)—20X AMPLITUDE setting, except 10X (2 A) at 200 mA/step and 15X (1.5 A) at 100 mA/step.

MAX VOLTAGE (steps and aiding offset)—at least 10 V.

MAX OPPOSING OFFSET CURRENT—10X AMPLITUDE switch setting or 10 mA, whichever is less.

MAX OPPOSING VOLTAGE—limited at 1 to 3 V.

RIPPLE plus NOISE— $\leq$0.5% of AMPLITUDE switch setting, or 1 nA P-P, whichever is greater.

VOLTAGE MODE

STEP AMPLITUDE RANGE—5 mV/step (with 0.1X MULT) to 2 V/step, 1-2-5 sequence.

MAX VOLTAGE (steps and aiding offset)—20X AMPLITUDE switch setting, 40 V max.

MAX CURRENT (steps and aiding offset)—at least 2 A at 10 V, derating linearly to 10 mA at 40 V.

SHORT CIRCUIT CURRENT LIMITING—20 mA, 100 mA, 500 mA, +100%, —0%; 2 A +50%, —0%.

MAX OPPOSING OFFSET VOLTAGE—10X AMPLITUDE switch setting.

MAX OPPOSING CURRENT—limited at 10 to 20 mA.

RIPPLE plus NOISE— $\leq$0.5% of AMPLITUDE switch setting or 2 mV P-P.

STEP RATES

0.5X, 1X(NORM), and 2X the collector supply rate, which is twice line frequency.

PULSED STEPS

80 or 300 μs width, +20% and —5%, at NORM or 0.5X rates.

STEP/OFFSET POLARITY

The STEP GEN polarity is the same as the COLLECTOR SUPPLY polarity, and positive in the AC position. Step polarity may be inverted by actuating the INVERT pushbutton.

STEP FAMILY

REPETITIVE or SINGLE FAMILY (manually actuated).

NUMBER OF STEPS

Digitally selectable between 1 and 10.

VERTICAL AND HORIZONTAL AMPLIFIERS

DISPLAY ACCURACIES

as a percentage of the highest on-screen value

NORM and DC MODES	NORMAL	OFFSET and MAGNIFIED with CENTERLINE VALUE from:		
		100-40 div	35-15 div	10-0 div
Vert Collector Current	3%	2%	3%	4%
Horiz Collector Volts	3%	2%	3%	4%
Horiz Base Volts	3%	2%	3%	4%
LEAKAGE MODE Vert Emitter Current/div:				
10 nA-2 mA/div	3% ± 1 nA			
1 nA-200 μA/div (magnified)		2% ± 1 nA	3% ± 1 nA	4% ± 1 nA
5, 2, 1 nA/div	5% ± 1 nA			
Horiz Collector or Base Volts with Emitter Current/div of:				
$\geq$1 μA	3%	2%	3%	4%
100, 10, or 1 nA	3% plus 25 mV/vert div	NOT APPLICABLE		
200, 20 or 2 nA	3% plus 50 mV/vert div			
500, 50 or 5 nA	3% plus 125 mV/ vert div			
VERT STEP GEN POSITION	4%	3%	4%	5%
HORIZ STEP GEN POSITION	4%	3%	4%	5%

VERTICAL DEFLECTION FACTOR

Collector Current—1 μA to 2 A/div, 20 steps in 1, 2, 5 sequence (0.1 μA/div with X10 magnification).

Emitter Current—1 nA to 2 mA/div, 20 steps in 1, 2, 5 sequence.

Step Generator—1 step/div.

HORIZONTAL DEFLECTION FACTOR

COLLECTOR VOLTS—50 mV to 200 V/div, 12 steps in 1-2-5 sequence (5 mV/div with X10 magnification).

BASE VOLTS—50 mV to 2 V/div, 6 steps in 1, 2, 5 sequence (5 mV/div with X10 magnification).

STEP GENERATOR—1 step/div.

DISPLAYED NOISE

≤1%, or

	15 V	75 V	350 V	1500 V
VERTICAL—COLLECTOR	1 μA	1 μA	2 μA	5 μA
VERTICAL—EMITTER	1 nA	1 nA	2 nA	5 nA
HORIZONTAL—BASE	5 mV	5 mV	5 mV	5 mV
HORIZONTAL—COLLECTOR	5 mV	5 mV	20 mV	200 mV

CALIBRATOR (CAL)

DC voltage (accurate within 1.5%) provided to check and adjust vertical and horizontal gain.

POSITION CONTROLS

Fixed 5-div increments within 0.1 div. Continuous fine control over ≥5 div.

DISPLAY OFFSET

Provides 21 calibrated positioning increments, vertically or horizontally, of 0.5 div or 5 div with the X10 MAGNIFIER.

CRT AND READOUT

CRT

6½-inch rectangular with parallax-free, illuminated graticule in centimeters. The calibrated area is 10 cm vertical by 10 cm horizontal (12 cm usable horizontal). P31 phosphor normally supplied; P2 and P7 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability.

READOUT

The readouts, adjacent to the CRT, are digital indicators of the following display parameters:

PER VERT DIV—1 nA to 2 A/div

PER HORIZ DIV—5 mV to 200 V/div

PER STEP—5 nA to 2 A/step, 5 mV to 2 V/step

β (BETA) or g_m PER DIV—1 μ to 500 k calculated from CURRENT/DIV, X10 MAG, STEP AMPLITUDE, and 0.1X MULT

OTHER CHARACTERISTICS

STANDARD TEST FIXTURE

A plug-in fixture with two sets of 5-pin test terminals, the EMITTER GROUNDED or BASE GROUNDED switch, Left-Off-Right switch, STEP GEN OUTPUT, EXT BASE or EMITTER input, and the OPERATOR PROTECTION BOX. The test terminals accept either the 6-pin universal adapters, 3-pin adapters, or the high-power transistor adapters with KELVIN contacts.

POWER REQUIREMENTS

POWER SOURCE—operates only with an unbalanced-to-ground power source. For safe operation, the power line neutral (white or "identified" conductor) must be connected to the instrument neutral (unfused), and the power plug safety ground (green conductor) must return to ground through a different path than the power line neutral.

VOLTAGE RANGES—The quick-change line-voltage range selector accommodates 90 VAC to 136 VAC or 180 VAC to 272 VAC (six positions), at 48 Hz to 66 Hz line frequency. Max power consumption is 305 W (3.2 A), standby power ≈60 W.

AMBIENT TEMPERATURE

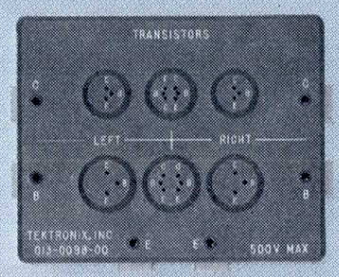
Performance characteristics are valid over a temperature range of +10°C to +40°C.

DIMENSIONS AND WEIGHTS

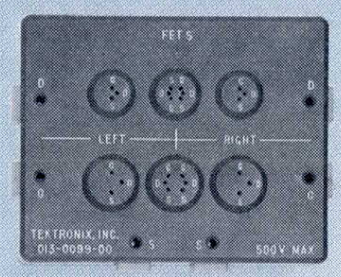
Height	15 in	38 cm
Width	11½ in	29 cm
Depth	23 in	59 cm
Net weight	70½ lb	32 kg
Domestic shipping weight	≈107 lb	≈48.5 kg
Export-packed weight	≈127 lb	≈57.5 kg

INCLUDED STANDARD ACCESSORIES

TEST ADAPTERS



013-0098-00



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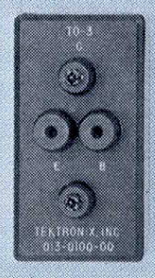
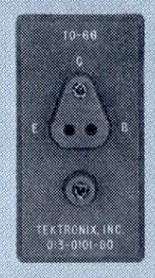
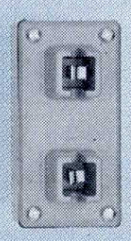


2 Each
013-0100-00



2 Each
013-0101-00



2 Each
013-0072-00

Not shown: 3 to 2-wire adapter (103-0013-00); measurement concepts booklet "Semiconductor Device Measurements" (062-1009-00); two instruction manuals (070-0905-00).

TYPE 576 CURVE TRACER **$2250**

INSTRUMENT OPTION

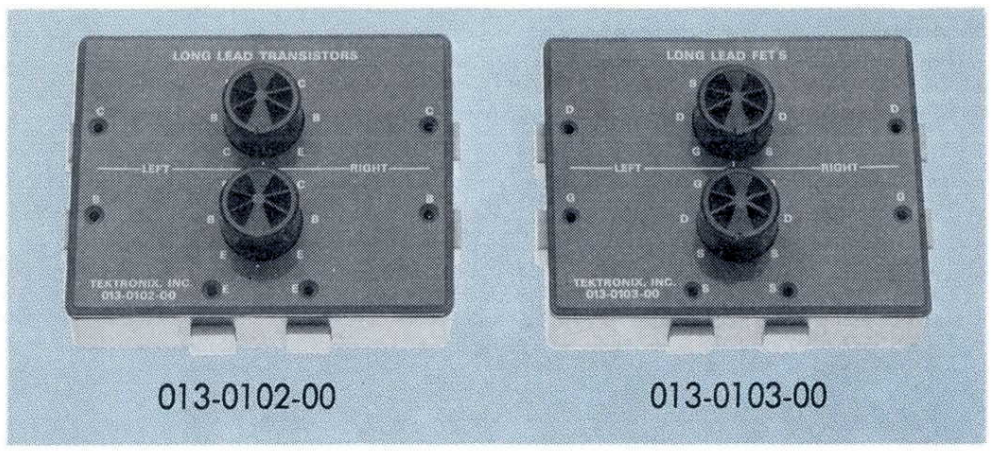
The Type 576 MOD 301W deletes the parameter readout module but maintains provision for insertion.

Type 576 MOD 301W $1975

Scale Factor Readout Module (020-0031-00) ..... $ 330

OPTIONAL ACCESSORIES

LONG-LEAD ADAPTERS



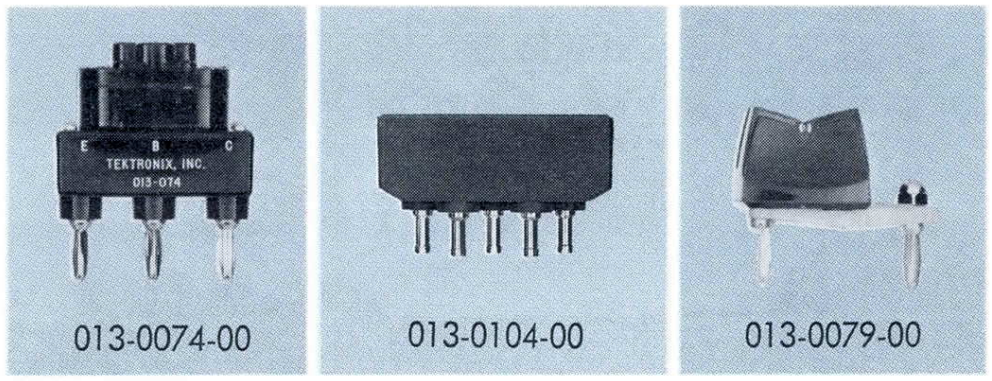
013-0102-00 013-0103-00

Designed to accept untrimmed bipolar or single FET's or transistors.

Long-lead transistor adapter, order 013-0102-00 ..... $28

Long-lead FET adapter, order 013-0103-00 ..... $28

OTHER ADAPTERS



013-0074-00 013-0104-00 013-0079-00

ADAPTER BOX

Blank, for mounting special semiconductor sockets.

Order 013-0104-00 ..... $ 8

POWER TRANSISTOR ADAPTER

For power transistors with hook leads.

Order 013-0074-00 ..... $8.30

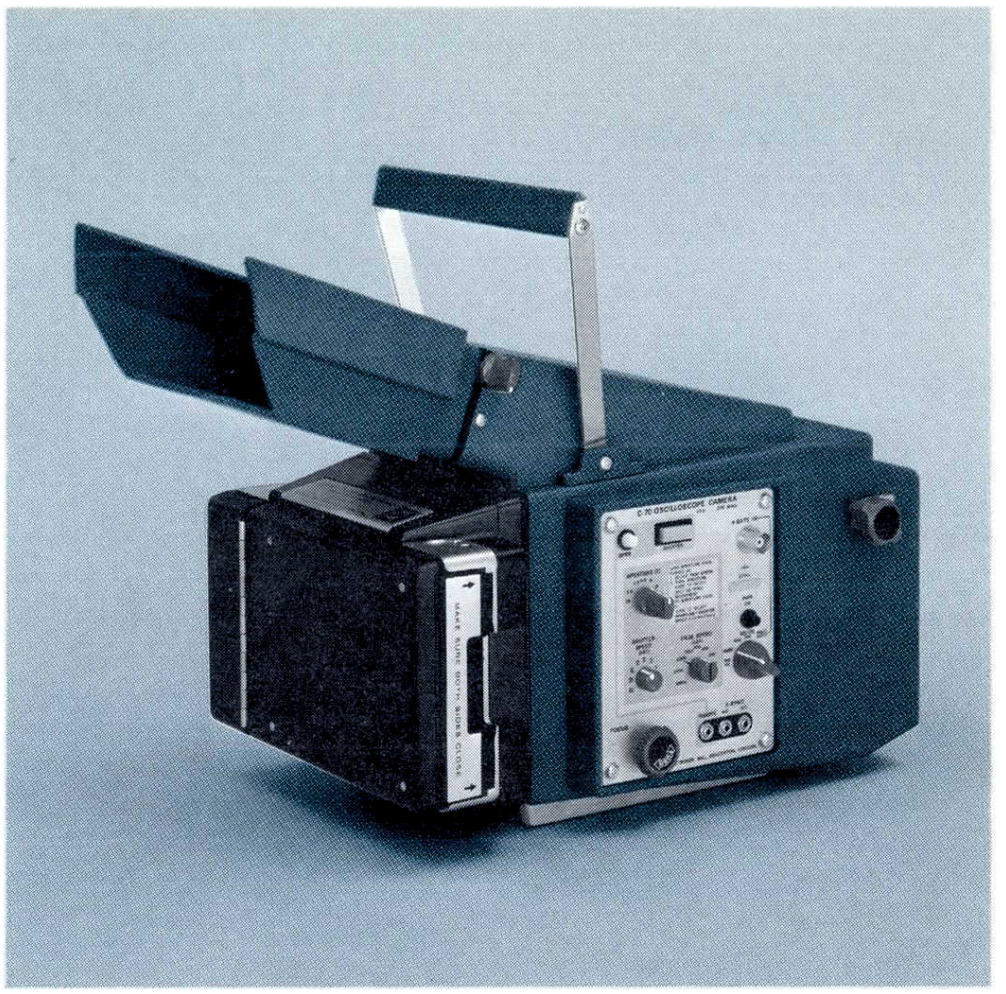
DIODE ADAPTER

Magnetic holder for axial lead diodes, providing quick insertion and removal for production applications.

Order 013-0079-00 ..... $29

OTHER

Adapters for stud-type power transistors and diodes will be available mid-1970.



CAMERA

The C-70 camera is a general-purpose trace-recording camera designed for use with the Type 576 Curve Tracer. It features a f/1.9, 1:0.575 lens, trace-brightness photometer, range-finder focusing, accurate eposure control, electric shutter, and choice of Polaroid[1] Land or Graflok[2] Film back.

C-70-P CAMERA, Pack-Film Back $785

C-70-R CAMERA, Roll-Film Back $785

C-70-G CAMERA, 4 x 5 Graflok Back $755

Adapter-frame/corrector lens, part no. 016-0264-00, permits use of the C-12 or C-27 Cameras with the Type 576, refer to the camera section of this catalog for full information.

SCOPE-MOBILE® CART

Model 202-1 with storage drawer $145

[1]Registered Trademark Polaroid Corporation

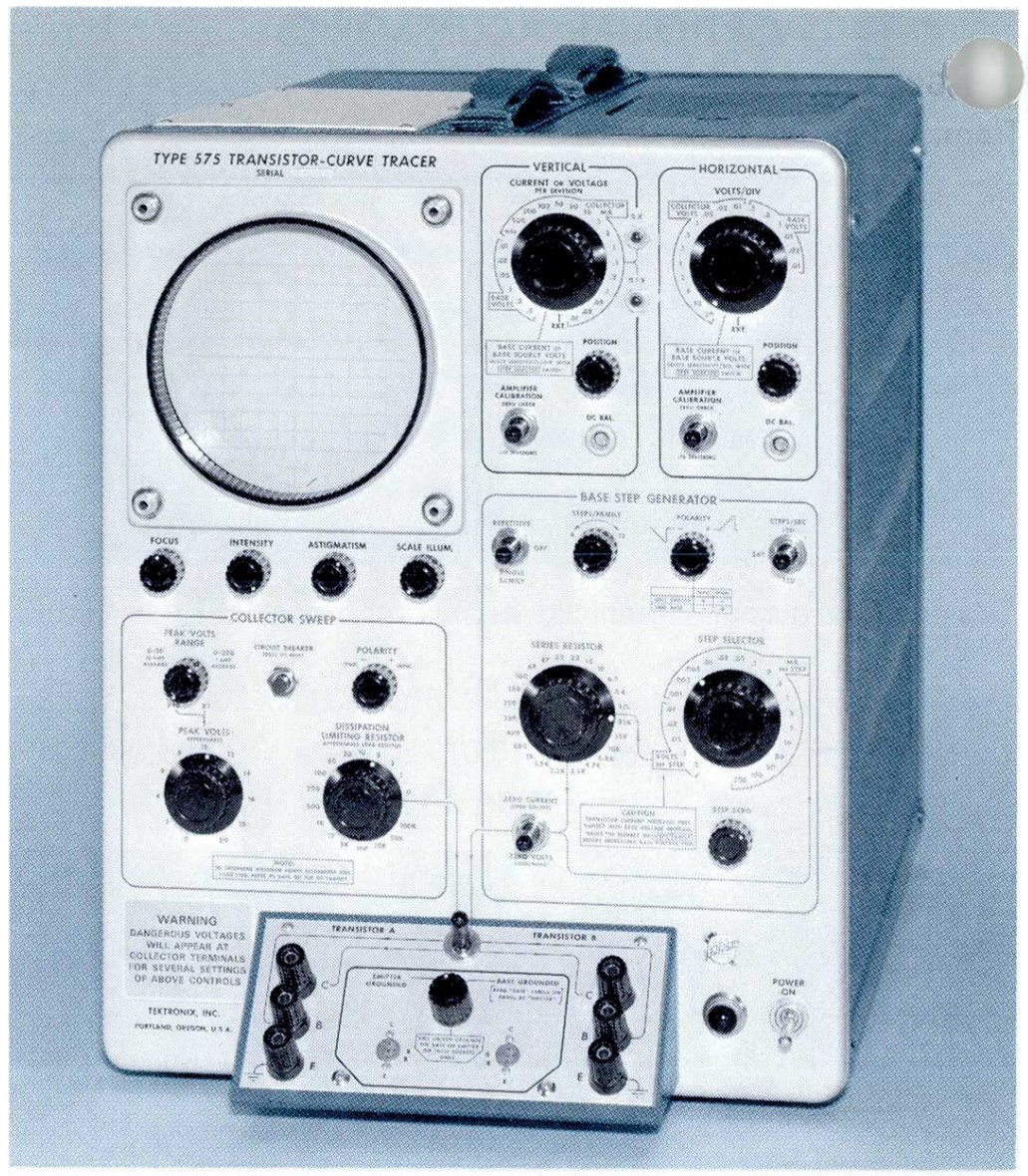
[2]Registered Trademark Graflex, Inc.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Semiconductor Curve Tracer

575

- ***DISPLAY DYNAMIC CHARACTERISTIC CURVES***
- ***DIRECT COMPARISON OF TRANSISTOR CHARACTERISTICS***
- ***MAKE DIODE MEASUREMENTS***



The Type 575 Transistor-Curve Tracer displays the dynamic characteristic curves of both NPN and PNP transistors. Several different transistor characteristic curves may be displayed, including the collector family in the common-base and common-emitter configuration. In addition to the transistor curves, the Type 575 is used to display dynamic characteristics of a wide range of semiconductor devices.

A special model (Type 575 MOD 122C), although similar to the Type 575, provides much higher voltages for diode breakdown test and collector supply. Horizontal deflection factor selections are extended to 200 V/div to accommodate the higher voltages.

Transistors under test are inserted into either a common-base or common-emitter test circuit. The transistor collector has a sweep voltage applied to it while a step voltage or current is applied to either the base or emitter (whichever is ungrounded). Voltage, for the collector, sweeps between zero and a selectable value. The Step Generator applies steps to the base or emitter that start at zero and build up to a value determined by the number of steps and value of each step as selected with front-panel controls. Each sequence of steps, in conjunction with the sweep voltage on the collector, produces one family of characteristic curves.

CHARACTERISTIC SUMMARY

BASE OR EMITTER STEP GENERATOR—

Type of Steps—Steps are increments of voltage or current and are either positive or negative.

Voltage Increments—Selectable from 10 mV/step to 0.2 V/step ±3% with 2.4-A current capability.

Current Increments—Selectable from 1 μA/step to 200 mA/step, ±3%.

Stepping Rate—2 or 4 times line frequency.

Number of Steps—Continuously variable from 4 to 12 steps per family of characteristic curves.

Single or Repetitive—Stops after a single family of curves is generated, or repeatedly generates the family of curves.

COLLECTOR SWEEP GENERATOR—

Frequency—2 times line frequency.

Peak Sweep Voltage—Continuously variable from 0 V to 20 V minimum with 10-A capability and from 0 V to 200 V minimum with 1-A capability.

Type 575 MOD 122C: Continuously variable from 0-20 V minimum with 10-A capability, 0-200 V minimum with 1-A capability or 0-400 V minimum with 0.5-A capability.

Polarity—positive or negative. A third switch position is added on Type 575 MOD 122C providing + and — (AC) 0 to 1500 V for diode breakdown tests.

VERTICAL DISPLAY

CALIBRATED DEFLECTION FACTOR—

Transistor Collector Current—1 μA/div to 2 A/div, ±3%.

Transistor Base or Emitter Current—1 μA/div to 200 mA/div, ±3%.

Transistor Base or Emitter Voltage—10 mV/div to 0.5 V/div, ±3%.

Base or Emitter Source Voltage—10 mV/div to 0.2 V/div, ±3%.

HORIZONTAL DISPLAY

CALIBRATED DEFLECTION FACTOR—

Transistor Collector Voltage—10 mV/div to 20 V/div, ±3%. MOD 122C—10 mV/div to 200 V/div, ±3%.

Transistor Base or Emitter Current—1 μA/div to 200 mA/div, ±3%.

Transistor Base or Emitter Voltage—10 mV/div to 0.5 V/div, ±3%.

Base or Emitter Source Voltage—10 mV/div to 0.2 V/div, ±3%.

CRT

DISPLAY AREA—10 x 10 div ($5/16$ inch per div).

ACCELERATING VOLTAGE—4 kV.

PHOSPHOR—P31

OTHER CHARACTERISTICS

COMPARISON SWITCH—Switch allows switching between two semiconductors for comparison.

POWER REQUIREMENTS—105 to 125 V or 210 to 250 V, 50 to 60 Hz, 410 watts max.

COLLECTOR SWEEP GENERATOR

The Collector Sweep Generator provides the sweep voltages that drive the collector of the transistor under test. These voltages sweep between zero and a peak value selected with a front-panel control. The peak voltage is either positive or negative depending on the setting of the polarity switch to allow the collector voltages to sweep between zero and positive peak values or zero and negative peak values. The repetition rate of the sweep is 2 times the line frequency; thus the collector voltage sweeps between zero and the peak value at least once for each step applied to the transistor base or emitter.

The peak sweep voltage is continuously adjustable from zero to 20 V with 10-A capability or from zero to 200 V with 1-A current capability. (Additional 0 to 400-V with 0.5-A current capability is provided on Type 575 MOD 122C.)

The collector current limiting resistance is selected from 16 values ranging from 1 ohm to 100 kilohms ±5%.

On Type 575 MOD 122C, a third position has been added to the POLARITY switch, providing + and — (AC) 0 to 1500 V.

BASE OR EMITTER STEP GENERATOR

The Step Generator develops current or voltage steps to drive the base or emitter (whichever is ungrounded) of the transistor under test. These steps are used to generate either repetitive or single-family (as selected) characteristic curves for display. The steps are adjustable in number from 4 to 12 and move in a positive or negative direction depending on the polarity switch setting. Step repetition rate is selectable as either 120 steps/s or 240 steps/s (values equal to 2X or 4X the line frequency). A control is available to set the starting point of a series of steps to zero.

Each step has a rise that is selected as either a value of current or a value of voltage. The value of each step rise in current ranges from 0.001 mA/step to 200 mA/step and is selected from 17 values that are in a 1-2-5 sequence. The value of each step rise in voltage is from 0.01 V/step to 0.2 V/step and is selected from 5 values that are in a 1-2-5 sequence. Also a switch is provided for grounding the transistor input to give a zero drive-voltage reference check, and opening the transistor input to give a zero drive-current reference check.

The driving resistance of the step generator, when developing voltage steps, is selected from 24 values that range from 1 ohm to 22 kilohms ±10%. Any other value can be added externally.

VERTICAL-DEFLECTION SYSTEM

Signals used for vertical deflection are selected from various points in the transistor test circuit. Each point has several selectable deflection factors available.

CALIBRATED DEFLECTION FACTOR

Transistor Collector Current—10 μA/div to 1 A/div in 16 steps, 1-2-5 sequence. Pushbuttons are provided for multiplying each step by 2 or 0.1 thus extending the deflection factor from 1 μA/div to 2 A/div.

Transistor Base or Emitter Current—1 μA/div to 200 mA/div in 17 steps, 1-2-5 sequence.

Transistor Base or Emitter Voltage—10 mV/div to 0.5 V/div in 6 steps, 1-2-5 sequence.

Base or Emitter Source Voltage—10 mV/div to 0.2 V/div in 5 steps, 1-2-5 sequence.

HORIZONTAL-DEFLECTION SYSTEM

Signals used for horizontal deflection are selected from various points in the transistor test circuit. Each point has several selectable deflection factors available.

CALIBRATED DEFLECTION FACTOR

Transistor Collector Voltage—0.01 V/div to 20 V/div in 11 steps, 1-2-5 sequence. (10 mV/div to 200 V/div on Type 575 MOD 122C).

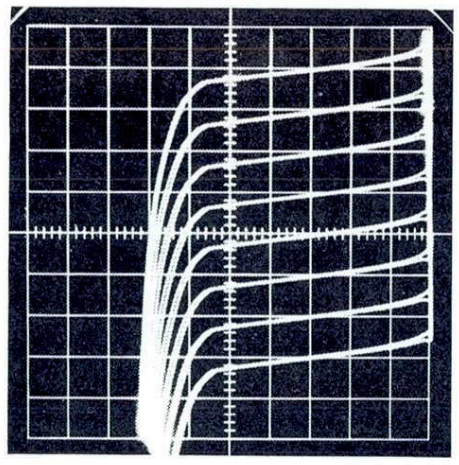
Transistor Base or Emitter Current—0.001 mA/div to 200 mA/div in 17 steps, 1-2-5 sequence.

Transistor Base or Emitter Voltage—0.01 V/div to 0.5 V/div in 6 steps, 1-2-5 sequence.

Base or Emitter Source Voltage—0.01 V/div to 0.2 V/div in 5 steps, 1-2-5 sequence.

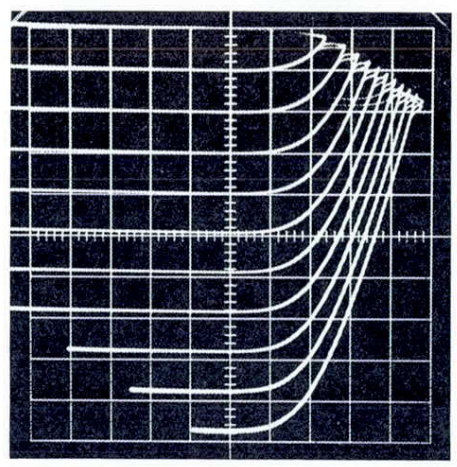
Semiconductor Curve Tracer

575



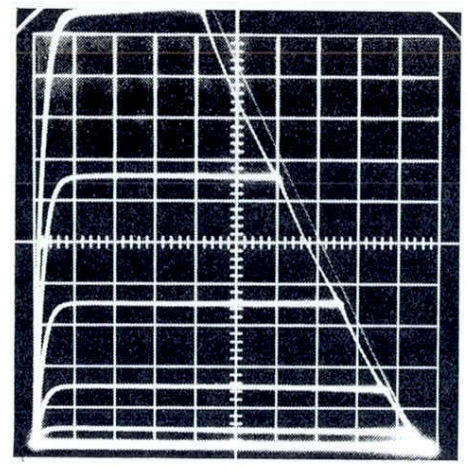
PNP TRANSISTOR

Collector current vs collector voltage with base grounded and constant-current emitter steps. Collector sweep is 0 to 120 V through a 5-k load resistor, emitter current 1 mA/step. Vertical deflection is 1 mA/div, horizontal deflection 10 V/div.



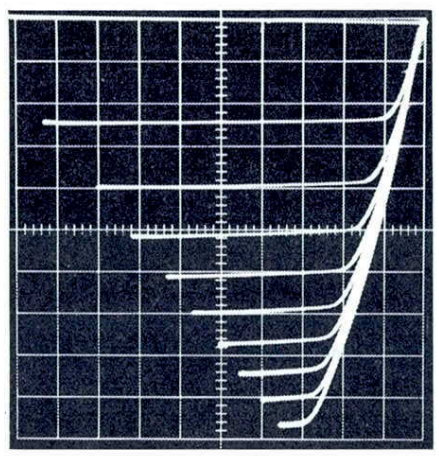
PNP TRANSISTOR

Collector current vs collector voltage with base grounded and constant-current emitter steps. Collector sweep is 0 to 1.5 V, emitter current 200 mA/step. Vertical deflection is 200 mA/div, horizontal deflection 0.1 V/div.



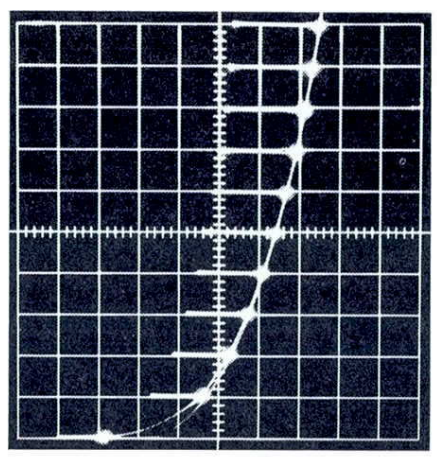
NPN TRANSISTOR

Collector current vs collector voltage with constant-voltage base steps. Collector sweep is 0 to 2 V, base voltage 0.02 V/step, vertical deflection is 5 mA/div, horizontal deflection 0.2 V/div.



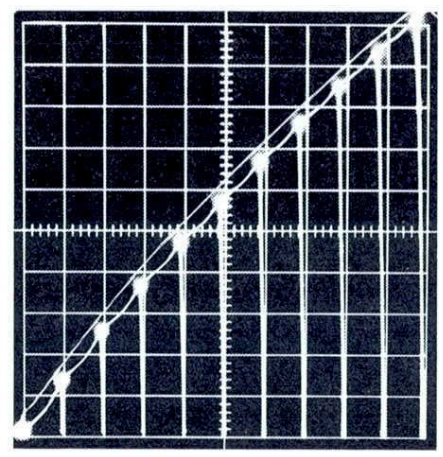
PNP TRANSISTOR

Collector current vs collector voltage with constant-current base steps. Collector sweep is 0 to 5 V with a 0.25-ohm load, base current is 50 mA/step. Vertical deflection is 1000 mA/div, horizontal deflection 0.5 V/div.



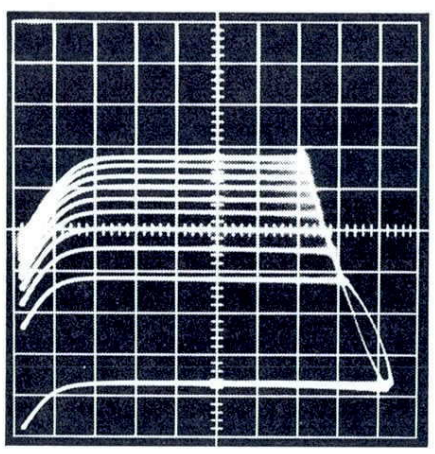
NPN TRANSISTOR

Base current vs base voltage with constant-current base steps. Collector sweep is 0 to 1 V, base current 0.1 mA/step. Vertical deflection is 0.1 mA/div, horizontal deflection 0.05 V/div. Dots represent equal increments of base current. Dynamic base impedance can be determined from this display.



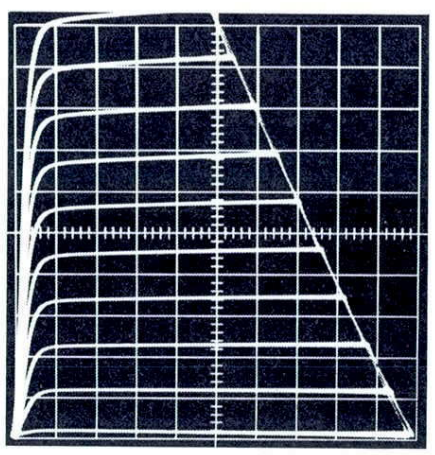
NPN TRANSISTOR

Collector current vs base current with constant-current base steps. Collector sweep is 0 to 1.5 V, base current 0.1 mA/step. Vertical deflection is 5 mA/div collector current, horizontal deflection 0.1 mA/div base current. Incremental and DC current gain can be determined from this display.



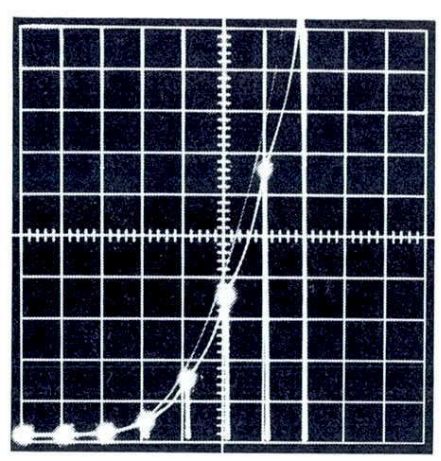
NPN TRANSISTOR

Base voltage vs collector voltage with constant-current base steps. Collector sweep is 0 to 1 V, base current 0.1 mA/step. Vertical deflection is 0.05-V/div base voltage, horizontal deflection 0.1-V/div collector voltage.



NPN TRANSISTOR

Collector current vs collector voltage with constant-current base steps. Collector sweep is 0 to 2 V, base current 0.01 mA/step. Vertical deflection is 0.5 mA/div, horizontal deflection 0.2 V/div.



NPN TRANSISTOR

Collector current vs base voltage with constant-voltage base steps. Collector sweep is 0 to 1.5 V, base voltage 0.05 V/step with a 1-ohm source impedance. Vertical deflection is 0.5 mA/div, horizontal deflection 0.05 V/div.

CRT

TEKTRONIX CRT
4-kV accelerating voltage, P31 phosphor normally supplied; P1, P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability.

GRATICULE
External, 3⅛ inch x 3⅛ inch viewing area, 10 divisions each axis with each division measuring 5/16 inch.

OTHER CHARACTERISTICS

TRANSISTOR TEST PANEL—The transistor test panel has provisions for two transistors at the same time. Two sockets accept low-power transistors with short leads and three binding posts alongside the sockets accept other transistors and semiconductors. One switch will change the sockets from the common-emitter to the common-base test circuit configuration. A second switch allows two transistors inserted into the test circuit to be rapidly compared by switching the test conditions from one to the other.

POWER REQUIREMENT
Wired for 105 to 125 VAC (117 V nominal); may be ordered with transformer taps connected for nominal values of 107, 127, 214, 234, or 254 V; 50 to 60 Hz. 410 watts maximum.

TYPE 575 AND TYPE 575 MOD 122C DIMENSIONS AND WEIGHTS

Height	16⅜ in	41.6 cm
Width	13 in	33 cm
Depth	23⅝ in	60 cm
Net weight	66¼ lb	30.1 kg
Domestic shipping weight	≈ 84 lb	≈38.2 kg
Export-packed weight	≈102 lb	≈46.4 kg

TYPE 575 AND TYPE 575 MOD 122C INCLUDED STANDARD ACCESSORIES
Two transistor adapters, long lead (013-0069-00); two transistor adapters, TO-3 (013-0070-01); 3 to 2-wire adapter (103-0013-00); two 2N1381 transistors (151-0039-00); 3-conductor power cord (161-0010-03); smoke-gray filter (378-0567-00); two instruction manuals (070-0255-01); measurement concepts booklet "Semiconductor Device Measurements" (062-1009-00).

TYPE 575 TRANSISTOR CURVE TRACER $1300

INCREASED COLLECTOR VOLTAGE

Type 575 MOD 122C, although similar to the Type 575, provides much higher diode breakdown test voltage (variable from zero to 1.5 kV, maximum short circuit current of 1 mA); also provides much higher collector supply (up to 400 V at 0.5 A).

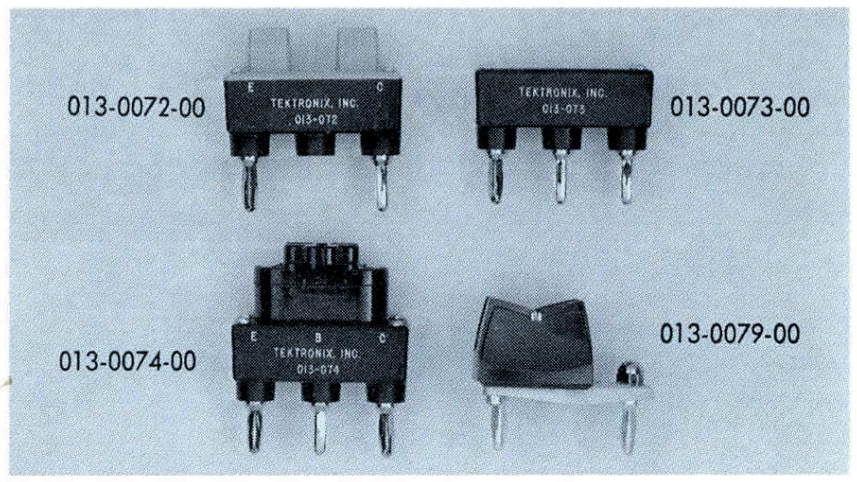
TYPE 575 MOD 122C TRANSISTOR CURVE TRACER $1575

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience. See catalog accessory pages for additional information on these and other items.

RACKMOUNT ADAPTER
Cradle mount to adapt the Type 575 Transistor-Curve Tracer for rackmounting. Consists of a cradle to support instrument in any standard 19-inch relay rack and mask to fit around regular instrument panel. Tektronix blue vinyl finish. Rack height requirements 17½ inch. Order 040-0281-00 . . . $34.50

TYPE 575 OPTIONAL TEST FIXTURES



DIODE TEST FIXTURE
Holds axial-lead diodes. Order 013-0072-00 ..... $ 6.60

ADAPTER BOX
Allows mounting of additional semiconductor sockets. Order 013-0073-00 ..... $ 4.40

POWER TRANSISTOR SOCKET
For power transistors with hook leads. Order 013-0074-00 ..... $ 8.30

DIODE TEST ADAPTER
Production test fixture for rapid handling. Order 013-0079-00 ..... $ 29.00

CAMERA
The standard C-12 camera satisfies most trace-recording requirements. For applications that might require a different viewing system, lens, or back, refer to camera descriptions or consult your Field Engineer, Representative, or Distributor.
Standard C-12: f/1.9 — 1:0.85 lens, on-axis, no parallax viewing, Polaroid Land* Pack-Film Back, order C-12 .. $490.00
Mounting Adapter for C-12, order 016-0226-01 .... $ 16.00

SCOPE-MOBILE® CART
Model 202-1: storage drawer, 9-position tilt-lock oscilloscope tray, order Type 202-1 ..... $145.00

*Registered Trademark, Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

High-Current Adapter

175

- ***200-A COLLECTOR DISPLAYS***
- ***12-A BASE SUPPLY***

The Type 175 Transistor-Curve Tracer High-Current Adapter enables the Type 575 to plot and display characteristic curves of high-current semiconductors. Basically the Type 175 contains a high-current Collector Sweep Generator, a high-current Base or Emitter Step Generator and high-current test circuits that are used in place of those in the Type 575. The 175 also contains the necessary circuits to convert these high currents into deflection signals suitable for display on the Type 575 CRT. There is one source for the vertical deflection signal: the transistor collector current. There are two sources for the horizontal deflection signal: transistor collector voltage and transistor base or emitter voltage.

CHARACTERISTIC SUMMARY

BASE OR EMITTER STEP GENERATOR

Type of Steps—Steps are increments of voltage or current and are either positive or negative.

Voltage Increments—Selectable from 20 mV/step to 0.5 V/step with 12-A current capability.

Current Increments—Selectable from 1 mA/step to 1 A/step.

Stepping Rate—2 or 4 times line frequency.

Number of Steps—Continuously variable from 4 to 12 steps per family of characteristic curves.

Single or Repetitive—Stops after a single family of curves is generated, or repeatedly generates the family of curves.

COLLECTOR SWEEP GENERATOR

Frequency—2 times line frequency.

Peak Sweep Voltage—Continuously variable from 0 V to 20 V with 200-A capability and 0 V to 100 V with 40-A capability.

Polarity—positive or negative.

VERTICAL

CALIBRATED DEFLECTION FACTOR

Transistor Collector Current—5 mA/div to 20 A/div.

HORIZONTAL

CALIBRATED DEFLECTION FACTOR

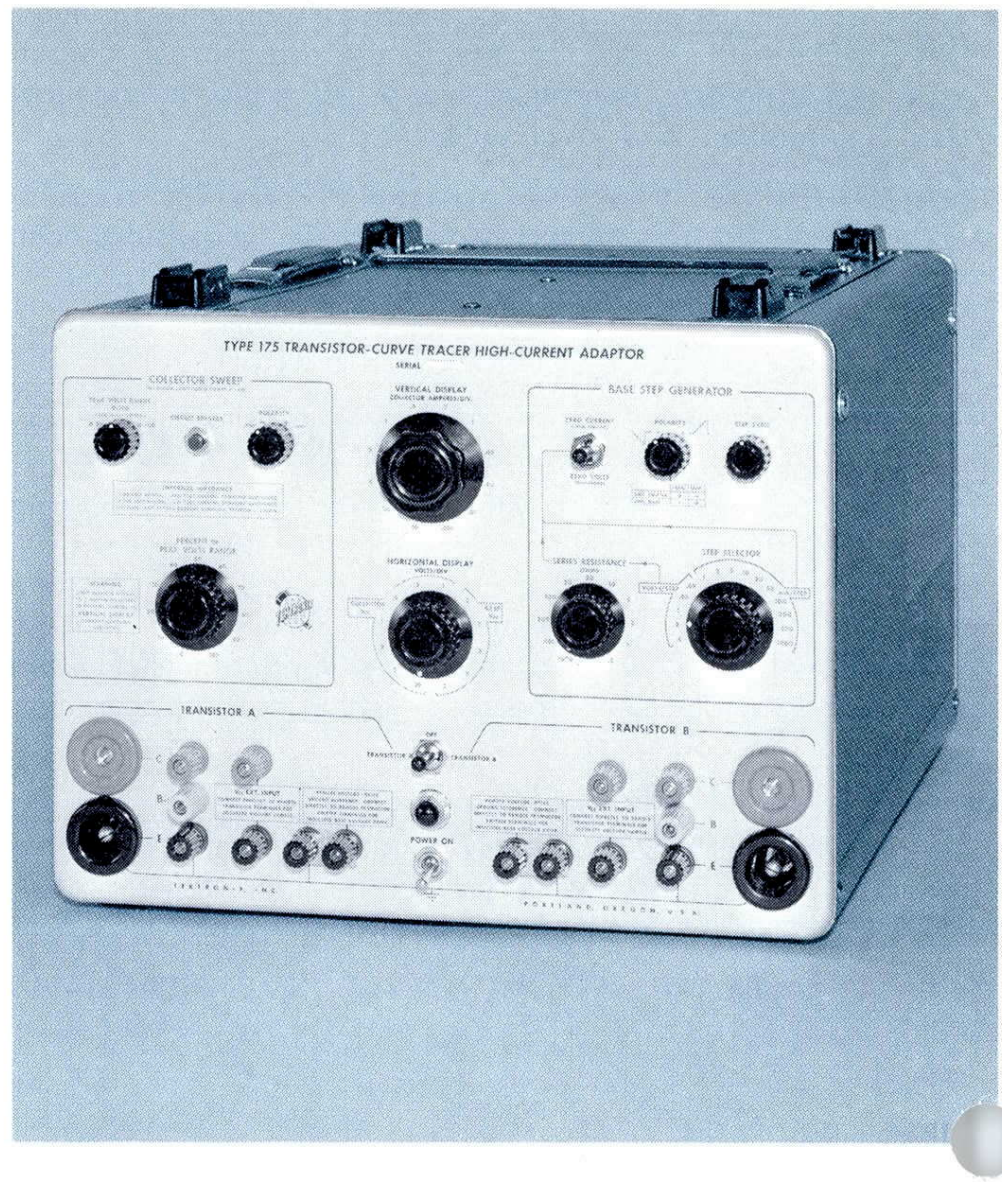
Transistor Collector Voltage—0.1 V/div to 10 V/div.

Transistor Base or Emitter Voltage—0.1 V/div to 2 V/div.

OTHER

COMPARISON SWITCH—Allows switching between two semiconductors for comparison.

POWER REQUIREMENTS—105 to 125 V, 50 to 60 Hz, 1100 watts max.



BASE STEP GENERATOR

The Type 175 step generator produces ten input steps of constant current from 1 mA/step to 1 amp/step and five input steps of constant voltage from 0.02 V/step to 0.5 V/step. A polarity switch provides for stepping the input in either the positive or negative direction. The STEPS/FAMILY control on Type 575 adjusts the number of steps per family from 4 to 12. A repetitive or single-family display can be presented. Either a 120-steps/s or 240-steps/s repetition rate can be selected. When used with a 50-hertz supply, the step/s rate will be either 100 or 200.

A switch grounds the transistor input for a zero voltage reference check, and opens the transistor input for a zero current reference check. The starting point of input current or voltage steps can be adjusted with the STEP ZERO control.

When constant-voltage input steps are in use, a resistance is inserted in series with the source impedance of the step generator. This driving resistance can be selected from eleven values, 0.5 ohms to 1,000 ohms.

High-Current Adapter

175

COLLECTOR SWEEP GENERATOR

The Collector Sweep Generator provides the sweep voltages that drive the collector of the transistor under test. These voltages sweep between zero and a peak value selected with a front-panel control. The peak voltage is either positive or negative depending on the setting of the polarity switch to allow the collector voltages to sweep between zero and positive peak values or zero and negative peak values. The repetition rate of the sweep is 2 times the line frequency; thus the collector voltage sweeps between zero and the peak value at least once for each step applied to the transistor base or emitter.

The peak sweep voltage is continuously adjustable from zero to 20 V with 200-A capability or from zero to 100 V with 40-A capability. Also, in the 0-100 V range a 300-ohm collector-current-limiting resistor can be switched in. Any other desired resistance can be added externally.

VERTICAL-DEFLECTION SYSTEM

The signal used for vertical deflection is the transistor collector current from the transistor test circuit.

CALIBRATED DEFLECTION FACTOR

Transistor Collector Current—5 mA/div to 20 A/div in 12 steps, 1-2-5 sequence.

HORIZONTAL-DEFLECTION SYSTEM

Signals used for horizontal deflection are selected from various points in the transistor test circuit. Each point has several selectable deflection factors available.

CALIBRATED DEFLECTION FACTOR

Transistor Collector Voltage—0.1 V/div to 10 V/div in 7 steps, 1-2-5 sequence.

Transistor Base or Emitter Voltage—0.1 V/div to 2 V/div in 5 steps, 1-2-5 sequence.

OTHER

TRANSISTOR TEST PANEL

The Type 175 Transistor Test Panel is basically the same as that of the Type 575. Special connectors and cables are provided for high-current applications and for eliminating measurement errors due to voltage drops in high-current carrying leads.

POWER REQUIREMENT

Type 175 wired for 105 to 125 V, 50 to 60 Hz, 1100 watts maximum. Type 175 MOD 167C wired for 210 to 250 V, 50 to 60 Hz, 1100 watts maximum.

TYPE 175 AND TYPE 175 MOD 167C DIMENSIONS AND WEIGHTS

Height	12 1/16 in	30.7 cm
Width	13 1/16 in	33.2 cm
Depth	23 5/8 in	60 cm
Net weight	83 1/2 lb	38 kg
Domestic shipping weight	≈117 lb	≈53.2 kg
Export-packed weight	≈139 lb	≈63.2 kg

TYPE 175 AND TYPE 175 MOD 167C STANDARD ACCESSORIES

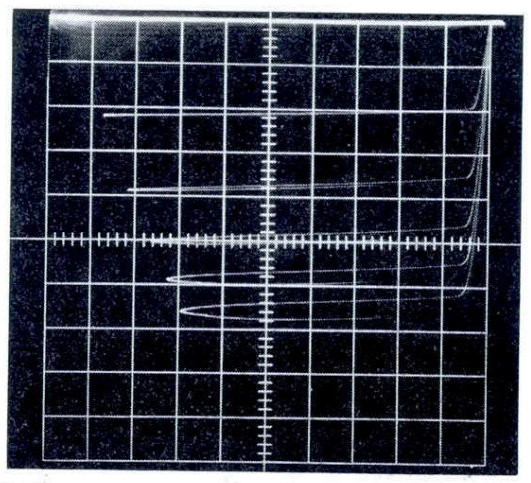
Two black output leads (012-0014-00); two red output leads (012-0015-00); interconnecting cable (012-0042-00); two red test cables (012-0043-00); two black test cables (012-0044-00); 575 adapter cable (012-0045-00); two blue test leads (012-0056-00); 3 to 2-wire adapter (103-0013-00); 3-conductor power cord (161-0030-01); 3-conductor power cord, 20-in (161-0014-01); two lock washers (210-0010-00); two nuts (210-0410-00); two screws (212-0520-00); two bolt hinges (214-0152-00); two instruction manuals (070-0255-01).

TYPE 175 HIGH-CURRENT ADAPTER $1775

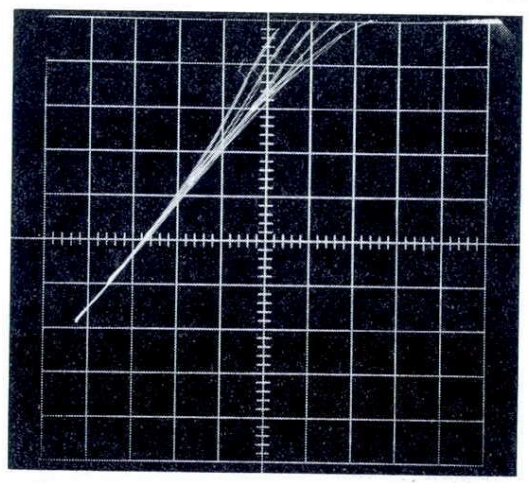
TYPE 175 MOD 167C $1775

Modifies the Type 175 for 210-250 volts, 50 to 60 Hz operation.

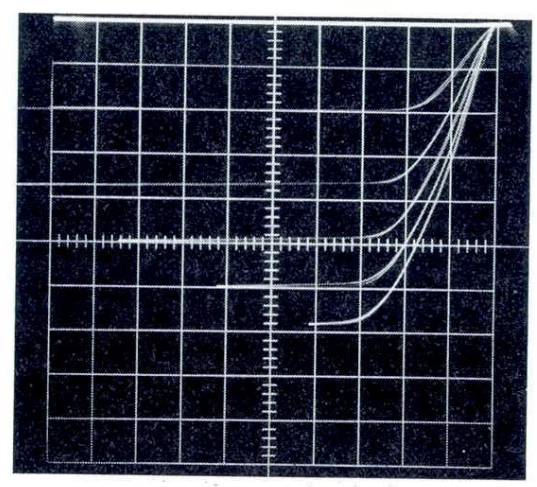
CHARACTERISTIC CURVE DISPLAYS WITH TYPE 175



Collector current vs collector voltage (emphasis on saturation resistance). Vertical deflection is 10 A/div, horizontal deflection is 0.2 V/div. Base drive is 500 mA/step (top curve is 2.5 A).



Collector current vs base voltage (collector sweep voltage is 4.2 V). Vertical deflection is 10 A/div, horizontal deflection is 0.1 V/div. Base drive is 500 mA/step.



Collector current vs collector voltage. Vertical deflection is 10 A/div, horizontal deflection is 1.0 V/div. Base drive is 500 mA/step (top curve is 2.5 A).

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Physiological Monitor Reference

SIGNALS FROM THE HUMAN BODY

The human body provides many indexes of relative well-being. Excessive body temperature has long been known to accompany ailments ranging from the minor to the serious. In a similar sense, and with varying degrees of reliability, eye dilation, pulse rate, respiration rate and others provide worthwhile information regarding the viability of the human body. When considered in the time domain, certain of these physiological indicators become more critically important and can yield substantially more information than others.

For example, one or two degrees of excessive body temperature persisting for several days would be of comparatively less cause for alarm than a heart stoppage for ten seconds. Moreover, the thermal mass of the body is such that hourly sampling might provide all the information required. But the nature of the heart is such that significant information may be observed from events lasting only a few hundredths of a second. Thus, the physiological signals can be classified according to (1) The magnitude of deviation from the norm, (2) The relative importance to the human body, (3) The rapidity with which the change can occur, and (4) The time duration of the shortest significant event within the data. Signals involving comparatively short duration cyclical events and potentially rapid change can yield considerable information when displayed in graphical form on a monitor such as the Type 410.

In the operating room, a physiological monitor provides information regarding reactions to anesthesia and surgical procedures. In the recovery room and the intensive care unit, which by their very existence indicates the importance of constant surveillance, the physiological monitor provides a continuous display of valuable data.

You can monitor any of three important physiological signals with the Type 410: ECG (or EKG, the Electrocardiogram)—An electrical signal produced by the heart which can be detected on the surface of the body.

Pulse—Pulsations of blood sensed in the finger or elsewhere with the appropriate transducer.

EEG—(Electroencephalogram) An electrical signal produced by the brain.

THE ELECTROCARDIOGRAM (ECG)

Among the key physiological indicators is the ECG: a graphical recording of the heart electrical activity. This signal is associated with the muscular contraction which produces the pumping action. Effective pumping requires coordination of the individual heart muscles, with related cyclical patterns in the electrical signal.

While the electrical signal occurs within the heart muscle tissue, it can be detected on the surface of the body. The sensing electrodes can be placed at many different sites and each pair or combination of electrodes provides a different perspective of the complex three-dimensional signal generator, the heart.

Figure 1 shows an idealized waveform representing the electrocardiogram from one of the more popular monitoring configurations which consists of a differential measurement between electrodes on the right arm and left leg, with a third electrode on the right leg serving as a common-mode reference to the monitoring system.

The information obtained from the ECG is far too broad and technically complex to detail here, but several general uses can be mentioned: (1) Heart rate can readily be determined as can improper rhythm. (2) Heart attacks may involve dead tissue and coagulated blood in portions of the heart which can produce an abnormal ECG. (3) Victims of electric shock may die due to heart fibrillation, a condition in which little or no blood is pumped by the heart. Fibrillation is a total loss of coordination between the various heart muscles which causes the heart to quiver rapidly rather than rhythmically contracting and expanding. Defibrillation can often be accomplished by applying a powerful electrical shock (up to 400 watt seconds in a ten-millisecond pulse) which temporarily locks the heart muscle. Within a few seconds after the intentional shock, the heart will often restart with the proper coordination. The electrical activity of the heart before and after defibrillation is readily monitored with the Type 410. Input circuitry of the instrument is protected against destruction by the defibrillator pulse so that there is no need to disconnect the monitoring electrodes during defibrillation.

THE PULSE

A normal ECG is no proof that blood is properly circulating throughout the body. Monitoring of the pulse by touch on the wrist, neck or elsewhere can show that blood is circulating, at least in that portion of the body and, in some cases, the judgement can be made that the pulse is "weak" or "strong". The Pulse Sensor can more than replace the conventional touch method. The sensor is easily attached to the patient and will provide continuous, hands-off monitoring.

As the blood pressure rises and falls with each heart beat, the amount of blood present in any particular portion of the flesh varies slightly with the expansion and contraction of the blood vessels. This slight change can be detected from the correspondingly slight change in the translucency of the flesh. A small, low-power incandescent lamp directs light into the flesh and an adjacent photo-resistor senses the light variation.

The finger tip, toe, and forehead are particularly good locations for the sensor. Contact pressure between the sensor and flesh is an important factor; excessive pressure will block blood flow and too little pressure will result in an excessive sensitivity to movement, thereby introducing interference. The Pulse Sensor is shown in Figure 2 with a removable finger adapter. This spring-loaded adapter not only holds the sensor against the finger with the proper pressure, but also excludes potentially interfering modulated light from fluorescent lamps or other sources. The adapter can be quickly attached and is self-holding on the finger.

For quick determination of heart rate, a direct reading Heart Rate Scale is provided across the top of the Type 410 graticule as shown in Figure 3. This scale is possible through the use of an automatically triggered sweep for ECG and pulse displays, and by the accurate sweep speeds of the Type 410. Three sweep speeds are provided: 25, 50, and 100 millimeters per second. The Heart Rate Scale is calibrated for use with the 50 mm/s speed.

The portion of the signal which has the greatest amplitude triggers the sweep and therefore appears at the lefthand edge of the graticule as shown in Figure 3. The corresponding portion of the next cycle appears to the right of the first at a distance determined by the time interval between the events and the horizontal sweep speed of the Type 410. From the known sweep speed and the measured distance, a simple calculation gives the pulse rate. The Heart Rate Scale is derived from this calculation and can be used with either a pulse or ECG display. (Display shows 75 beats/minute.)

While the event which produces sweep triggering remains stationary at the left-hand edge of the graticule with successive sweeps, the second event changes position with any variation in heart rate. If the heart rate is uniform, the display need be watched for only two or three seconds to obtain an accurate rate indication. The scale can also be used with slightly less accuracy with the other two sweep speeds: dividing by two on 25 mm/s and multiplying by two on 100 mm/s.

THE ELECTROENCEPHALOGRAM (EEG)

In some surgical procedures, the heart is intentionally stopped and blood circulation is maintained by an external mechanical pump, making it more difficult to determine the relative well being of the patient. In such cases the Type 410 can be used to monitor the EEG, the electrical activity of the brain. This complex signal, seemingly random to the layman (Figure 4),

can yield valuable information through analysis of amplitude and frequency content.

The EEG is detected on the surface of the head with electrodes similar to those used for ECG.

THE CLINICIAN AND HIS ENVIRONMENT

The Type 410 is of particular value to the anesthesiologist, a medical doctor specializing in anesthesiology. His activities in the operating room go far beyond the administration of anesthetics; he is responsible for monitoring patient well-being, assists the patient's breathing, monitors blood loss and replacement, monitors blood pressure, administers drugs, and in general watches for any unfavorable reaction due to the anesthetic or the surgical procedure.

Instrumentation which can provide some of the needed data can be of considerable value. To provide the anesthesiologist with continuous information, the Type 410 produces an audible "beep" coincident with the most significant event in each cycle of the ECG or pulse waveform. Most doctors and nurses, through experience, will be able to estimate heart rate quite accurately by listening to the "beep" and will most certainly be able to detect poor rhythm. Should a more qualitative determination of heart rate be desired, a quick look at the Heart Rate Scale will suffice. With the LOUDNESS control, the sound can be made audible to the entire surgical team or only to the anesthesiologist.

The operating room presents several unique restrictions to the use of instrumentation. The area immediately surrounding the operating table is often crowded with people and equipment. Certain of these people must move around during the operation and their pathway must not be obstructed by equipment, patient monitoring cables or power cords. Battery operation avoids power cords across the floor.

When a surgical operation is completed, the patient must often remain under close observation for several hours. The first stage of observation usually takes place in the recovery room adjacent to the operating room. It is sometimes undesirable to interrupt the electronic monitoring of the patient while moving from surgery to recovery room. Battery operation allows a monitor to be carried along with the patient for continuous monitoring.

MEASUREMENT BARRIERS

The real test of any physiological monitor is the fidelity with which it displays the bio-electric signal. The human body is considerably less than an ideal signal source. The signals of interest are small, about one millivolt. Unless the body is grounded, it usually bears an interfering 60-cycle signal of several volts which is electrostatically induced by power line sources such as nearby lighting fixtures and appliances. This signal will be common to all active signal leads to the monitoring device and is termed common-mode signal.

The outer layer of skin is of comparatively high resistance and is therefore an undesirable element in the signal path. Moreover, when a metallic electrode is placed upon the body, the body fluids constitute an electrolyte and one-half of a battery is formed. Dissimilarities among the several electrodes on the body can cause a DC voltage to exist between them. But since they form a poor battery, the terminal voltage can vary with patient movement, perspiration, etc. This voltage variation cannot be separated from the desired bio-electric signal and therefore must be eliminated at its source.

Certain desirable characteristics of a physiological monitor can now be described. High skin resistance must be reduced and any votage difference between electrodes must be small and stable. The monitor should be unaffected by the common-mode interference signal.

The ability of a monitoring system to reject a common-mode signal is often limited by an inability to transport the common-mode signal to the monitor by the two different paths without having the signal arrive at the monitor in dissimilar forms. If this happens, at least part of the signal is no longer in common mode, but has become a differential signal which cannot be rejected by the monitor. This problem can occur due to the skin resistance at each electrode forming an attenuator with the shunt input impedance to circuit ground within the monitor.

It is common practice to use a saline paste under each electrode to impregnate the skin, thus reducing the resistance between the highly conductive body fluids and the electrode. This can reduce skin resistance from a high of perhaps one megohm to as little as a few hundred ohms with careful preparation. However, a more practical degree of skin preparation will result in resistances ranging from one to five kilohms. Since it is highly unlikely that the resistances at the various electrode sites will match, it is probable that dissimilar attenuators will be formed with the monitor input circuitry. A few simple calculations will show that shunt impedances to circuit ground within the monitor of several hundred megohms are required to reduce this effect to an acceptable level.

A technique called "guarding" effectively multiplies the input impedances to several thousand times their actual values. The common-mode signal therefore arrives at the monitor in a form which permits virtually complete rejection.

SUMMARY

A Physiological Monitor is designed for patient surveillance. Only a few of the many necessary considerations have been discussed here: the physiological signals, the intended user, the environment, the fidelity of signal display, etc. The area of possible application is broad.

Please contact your local Tektronix Field Engineer for application assistance or problem solutions in YOUR work situation.

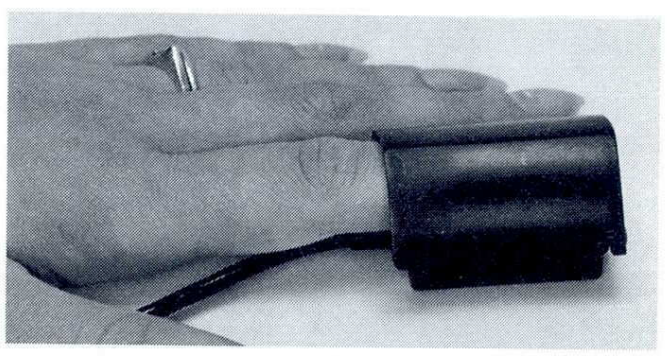


Fig. 2. Pulse Sensor

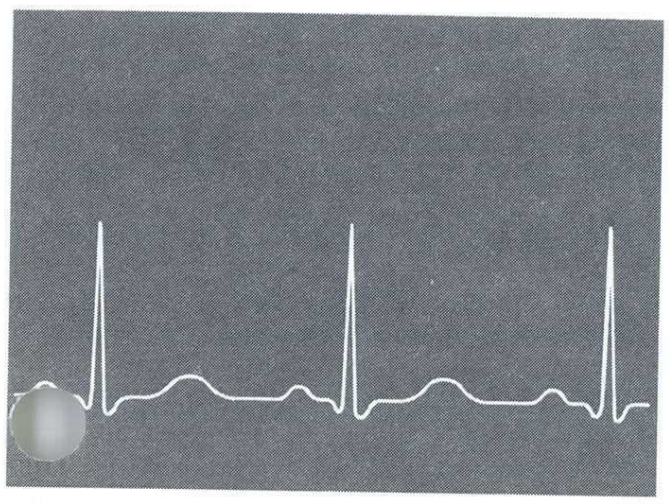


Fig. 1. ECG Waveform

Fig. 3. Pulse Sensor Waveform

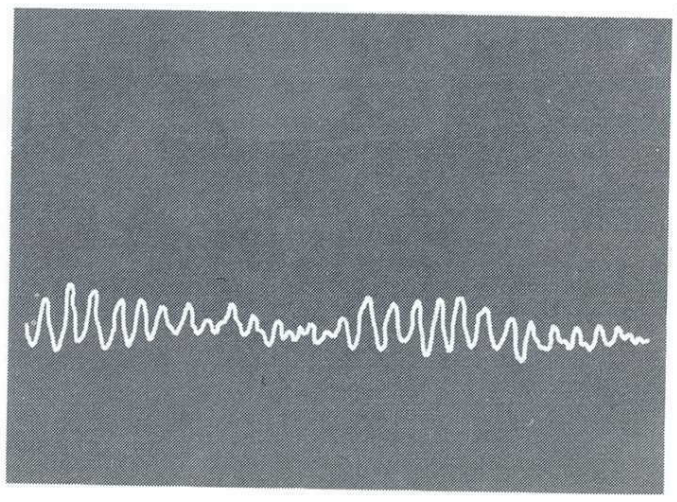


Fig. 4. EEG Waveform

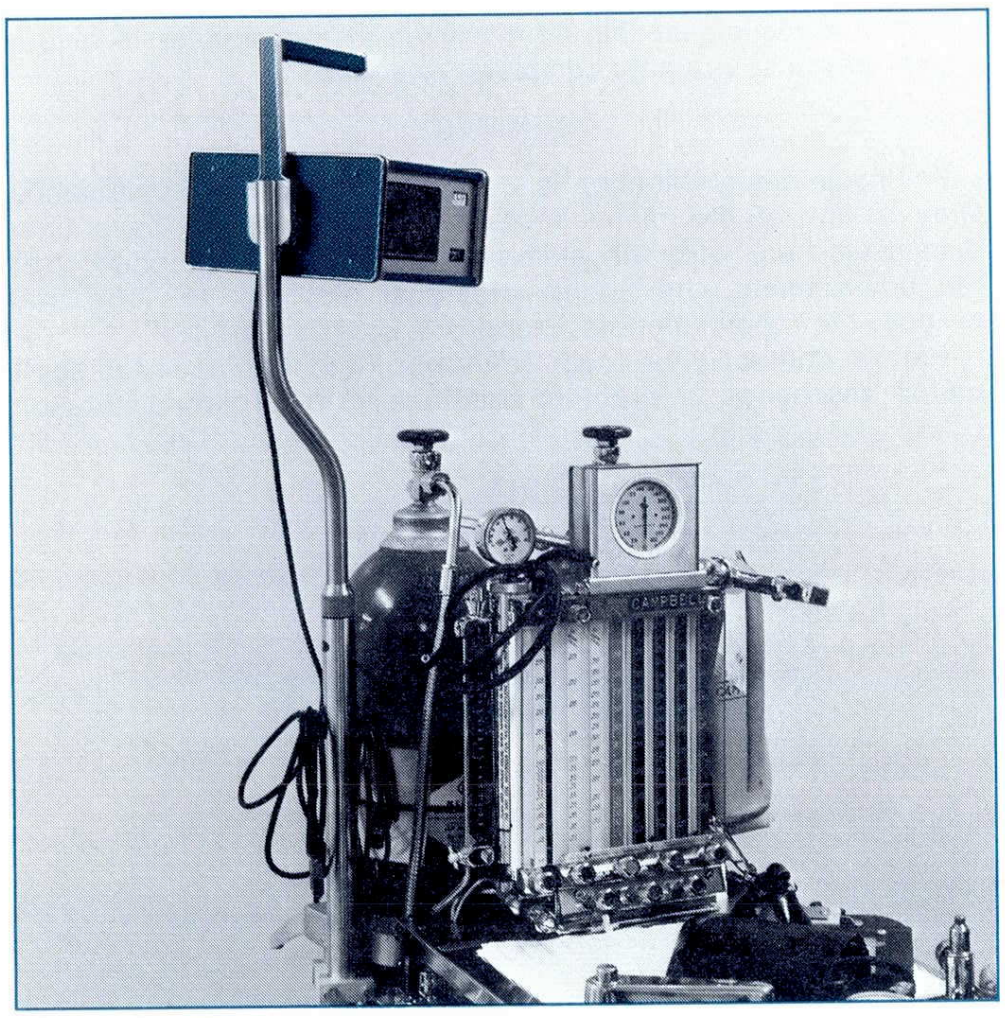
Physiological Monitor

410

- ***DISPLAYS ECG, EEG, OR PULSE WAVEFORMS***
- ***SIMPLE CONTROLS***
- ***SOLID-STATE RELIABILITY, QUICK TURN-ON***
- ***HEART RATE BEEP***
- ***PORTABLE, 12½ POUNDS***
- ***UP TO 8-HOURS OPERATION FROM INTERNAL BATTERY PACK***

The Type 410 is designed for patient monitoring during surgery, recovery, and intensive care. Of special use to the anesthesiologist, it displays on a cathode-ray tube waveforms of the electrocardiogram (ECG), electroencephalogram (EEG), or pulse. During surgery, the Type 410 can give early warning of a developing problem.

Ease of operation, with a minimum of controls, contributes to the usability of the Type 410, as do its other features: 4-second recovery after overdrive by defibrillator or cauterizer, output for strip-chart recorder, and a cabinet finish that is durable and washable.



The Monitor can be conveniently positioned (using the optional mounting fixture) at the five-foot level on the anesthesiologist's gas machine for easy viewing, then lifted off and carried with the patient to the recovery room. The 12½-pound weight and battery operation permit easy mobility and continuous operation without disconnecting leads or power.

ECG MEASUREMENTS

Heart rates from 35 beats/min to 180 beats/min can be directly read by observing the point on the CRT graticule scale where the second R wave occurs. A beep sound coincident with each repetition of the ECG waveform provides an audible indication of heart rate, in addition to the waveform display. Thus a sudden change in heart rate can be quickly detected, even without constant observation of the display. Loss of signal to the Monitor for 2 to 4 seconds automatically increases the rate of the beep to an alarm level, and also provides a baseline on the CRT. Bandwidth in the ECG mode is $\leq$0.1 Hz to 250 Hz $\pm$ 15%. Deflection sensitivity is 20 mm/mV $\pm$5%. Seven commonly-used leads can be selected: I, II, III, aV_R, aV_L, aV_F and V. Silver-silver chloride non-polarizing electrodes are supplied as standard accessories. The Type 410 is also compatible with common needle electrodes and inexpensive disposable surface electrodes.

EEG MEASUREMENTS

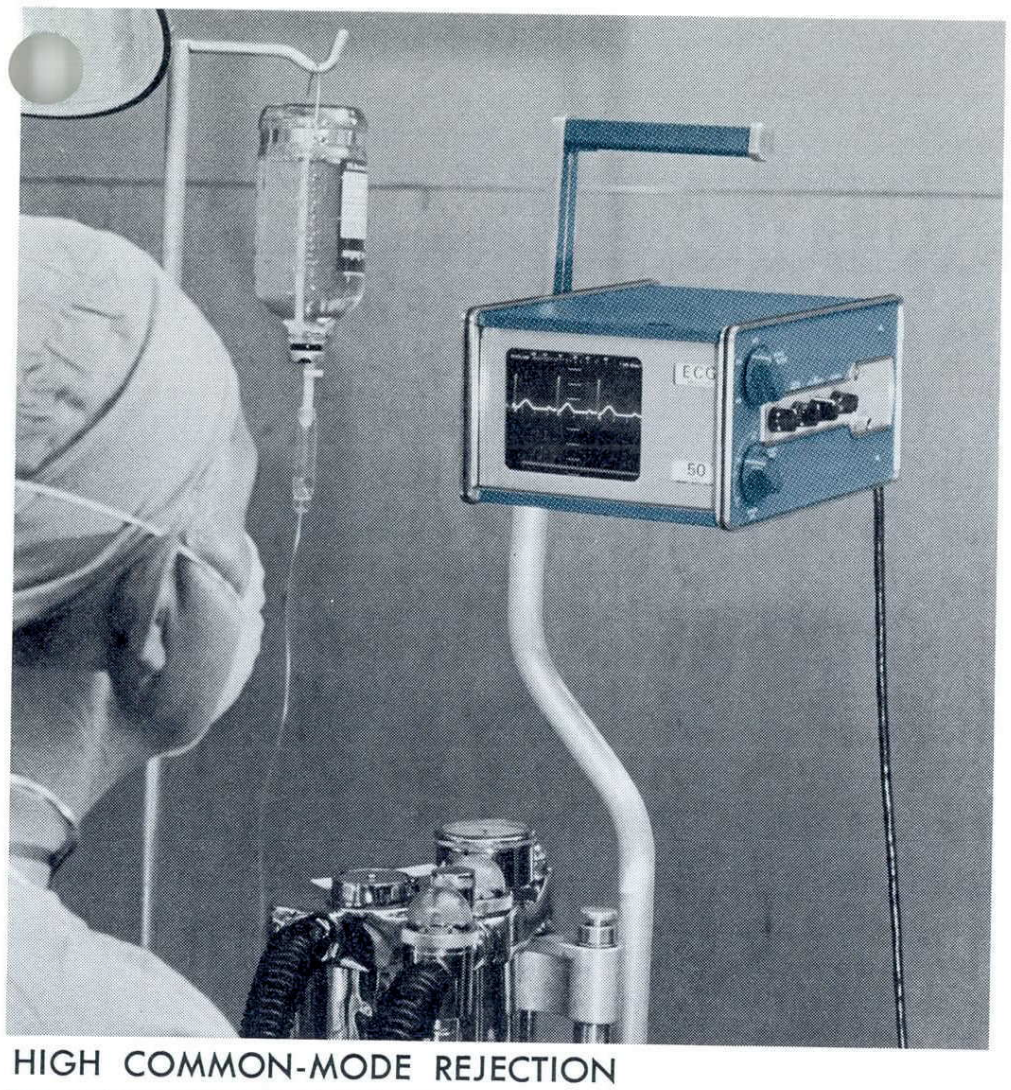
EEG input accepts the included silver-silver chloride ECG electrodes supplied with the Monitor. Optional EEG electrodes (identical except for color coding) are also available. Bandwidth in the EEG mode is $\leq$0.1 Hz to 100 Hz $\pm$15%. Deflection sensitivity is 10 mm/50 μV $\pm$5%.

PULSE MEASUREMENTS

Auxiliary input accepts the optional photosensitive pulse sensor. The pulse sensor, containing a light source and photo-resistor, is attached to the patient's finger. As the pulse occurs, the amount of blood in the finger changes the amount of light reaching the photo-resistor. The resulting display provides a quick indication of heart rate. A beep sounds coincident with each pulse, giving an audible as well as visible indication of the patient's heart activity. Loss of signal to the Monitor for 2 to 4 seconds automatically increases the rate of the beep to an alarm level, and provides a base line on the CRT. Bandwidth at the Auxiliary mode input is $\leq$0.1 Hz to 250 Hz $\pm$15%. Deflection sensitivity is 2 mm/mV $\pm$5%.

Physiological Monitor

410



HIGH COMMON-MODE REJECTION

Mode \ Signal Input Conditions	60 Hz and 5 kΩ Source Impedance Unbalance	25 Hz to Upper Bandwidth Limit and 0 Ω Source Impedance Unbalance
ECG	At least 150,000:1	At least 500,000:1
ECG (Lead Selector I, II or III)	At least 150,000:1	At least 500,000:1
ECG (Lead Selector aV_R, aV_L, aV_F, or V)	At least 100,000:1	At least 100,000:1
(With 100 mV DC differential voltage) EEG or ECG	- - -	At least 150,000:1
AUX	At least 50,000:1	At least 500,000:1

COMMON-MODE DYNAMIC RANGE

+3 V to −3 V.

DIFFERENTIAL DYNAMIC RANGE

Monitor gain characteristics are valid with an input terminal DC potential difference (offset) of up to 50 mV. Typically less than 10 mV difference exists between the non-polarizable silver-silver chloride electrodes supplied with the Type 410. At least 100 mV of either polarity can be applied with no more than 5% reduction in amplifier gain.

DIFFERENTIAL INPUT RESISTANCE

2 MΩ ±15% in EEG and ECG mode, 20 MΩ ±15% in Auxiliary mode.

DRIFT

≤0.5 cm per hour after 10-second warm-up.

DISPLAY NOISE

≤0.1 cm in the calibrated EEG mode, input shorted.

SWEEP SPEEDS

25, 50, and 100 mm per second; accurate within 5%. Sweep is triggered in ECG and AUX operating modes.

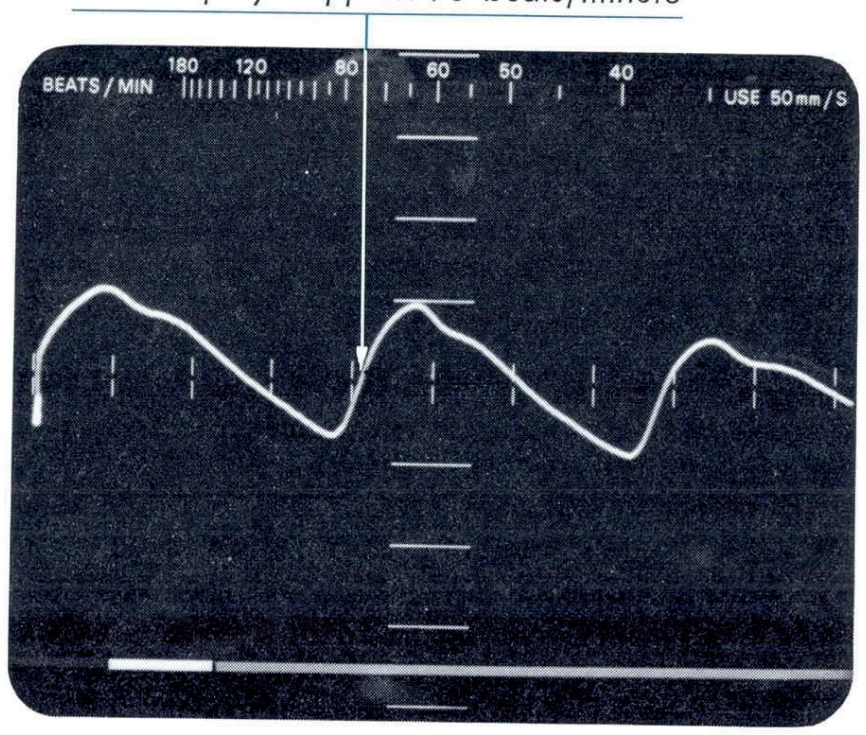
AUDIO SIGNAL

Beep sounds at heart rate, providing audible indication of normal or arrhythmic heart rate. Automatic alarm sounds if there is a loss of signal for 2 to 4 seconds. Loudness is adjustable. Using the audio output jack disconnects the internal speaker.

WAVEFORM SIZE

Vertical size of ECG, EEG, and pulse waveforms is continuously variable from ⅓ to 3 times the height of the calibrated display.

Pulse display—approx 75 beats/minute



CRT

5-inch rectangular CRT has 8 x 10-cm viewing area. P-7 phosphor has long decay time for convenient viewing at slow sweep speeds. The external graticule has a graduated heart-rate scale at the top, a battery-condition scale at the bottom, and a vertical and horizontal center-line scale marked in centimeters.

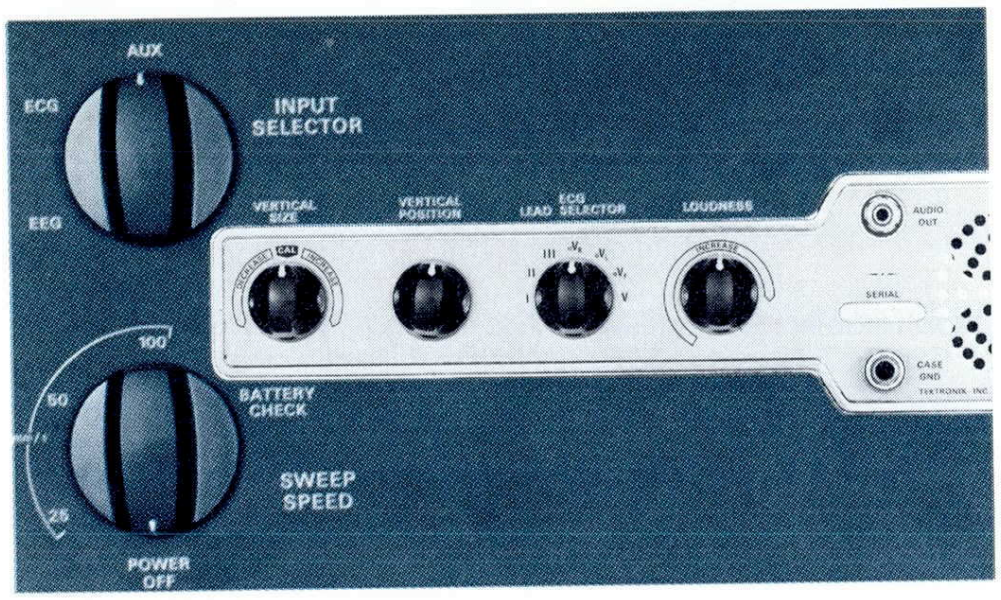
BATTERY OPERATION

Removable battery pack contains 10 size "C" NiCd cells, provides 6 hours operation with full accessory load when display baseline stays within 3 divisions of graticule center, increasing to 8 hours in ECG or EEG with baseline kept within 1 division of graticule center. Time decreases above 25° C. Internal charger provides recharge in 14 to 16 hours, operates from 90 V to 136 VAC or 180 V to 272 VAC, 48 Hz to 440 Hz, requires ≤7 W at 115 V, 60 Hz. Monitor can also be operated from line (with reduced charge to battery pack).

The battery pack incorporates an automatic battery disconnect. It automatically terminates battery discharge before batteries can be harmed. The disconnect is activated if the instrument is operated for a prolonged period of time with the battery condition indicating in the red area of the battery check scale.

CLEANING

Monitor and accessories can be damp wiped with mild soap and water.

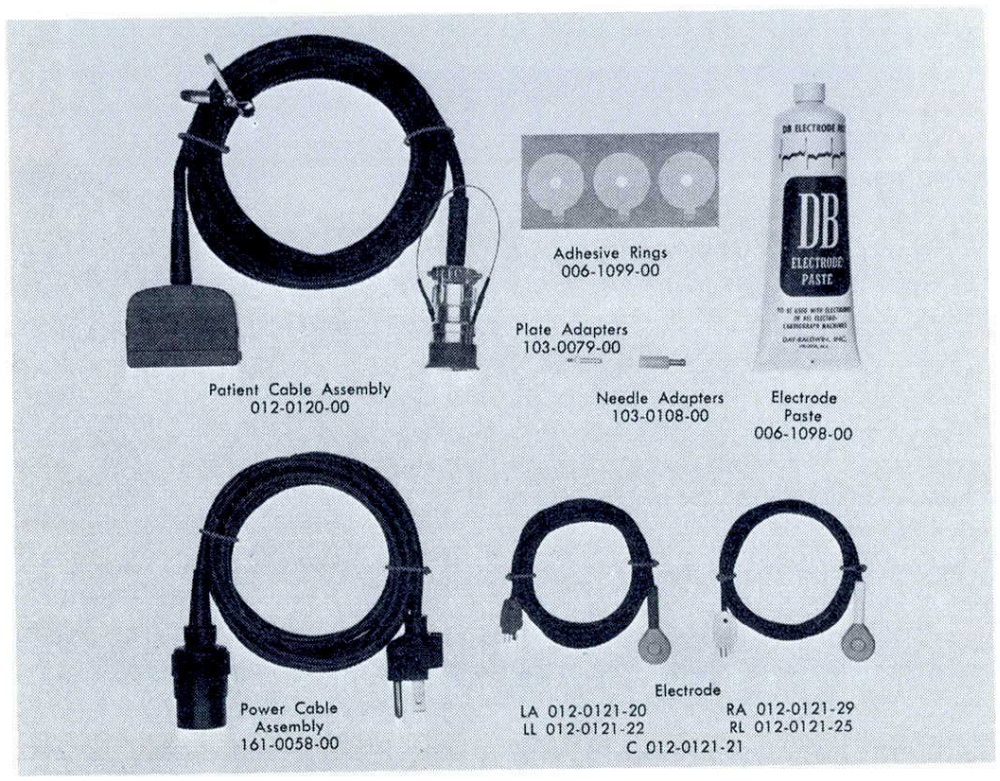


Type 410 operating controls.

DIMENSIONS AND WEIGHTS

Height	5⅜ in	13.7 cm
Width without handle	8½ in	21.6 cm
Width with handle	9⅛ in	23.2 cm
Depth without handle	10¾ in	27.4 cm
Depth with handle	12⅞ in	32.7 cm
Weight without accessories	12½ lb	5.6 kg
Domestic shipping weight	≈20 lb	≈9.1 kg
Export-packed weight	≈30 lb	≈13.6 kg

REPRESENTATIVE ACCESSORIES



INCLUDED STANDARD ACCESSORIES

Power cable assembly (161-0058-00); patient cable assembly (012-0120-00); electrode LA black (012-0121-20); electrode LL red (012-0121-22); electrode RL green (012-0121-25); electrode RA white (012-0121-29); electrode, chest, brown (012-0121-21); package adhesive electrode rings (006-1099-00); tube electrode paste (006-1098-00); five needle adapters (103-0108-00); five plate adapters (103-0079-00); two instruction manuals (070-0658-00).

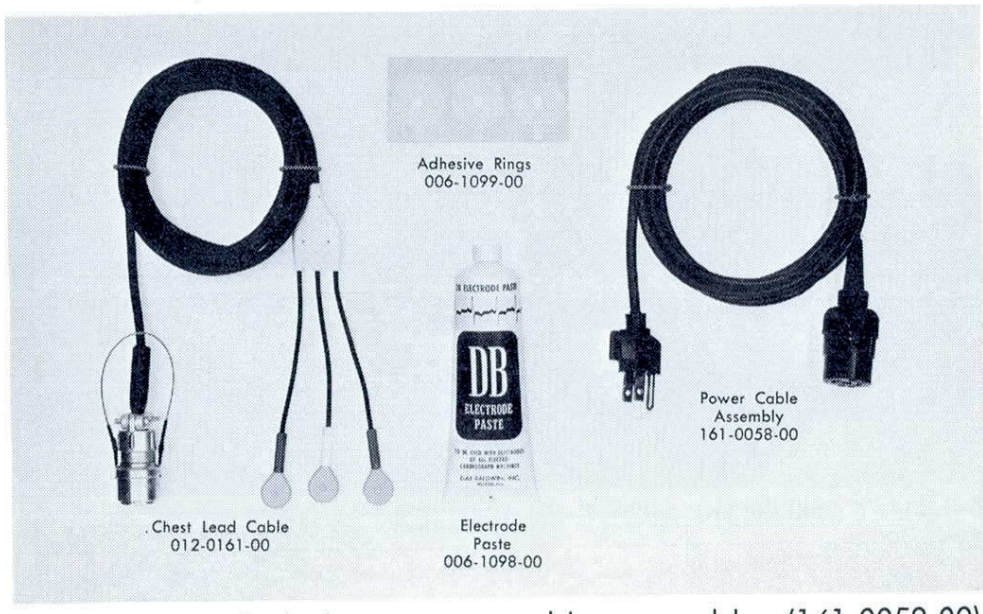
TYPE 410 PHYSIOLOGICAL MONITOR $875

INSTRUMENT OPTIONS

The Type 410 may be purchased without the full complement of standard accessories. These options allow maximum flexibility and value for the user who will be operating a Type 410 in an area where limited types of signals require monitoring. If requirements are expanded subsequent to initial purchase, additional accessory packages are available. (see OPTIONAL ACCESSORIES listing)

CHEST LEAD OPTION

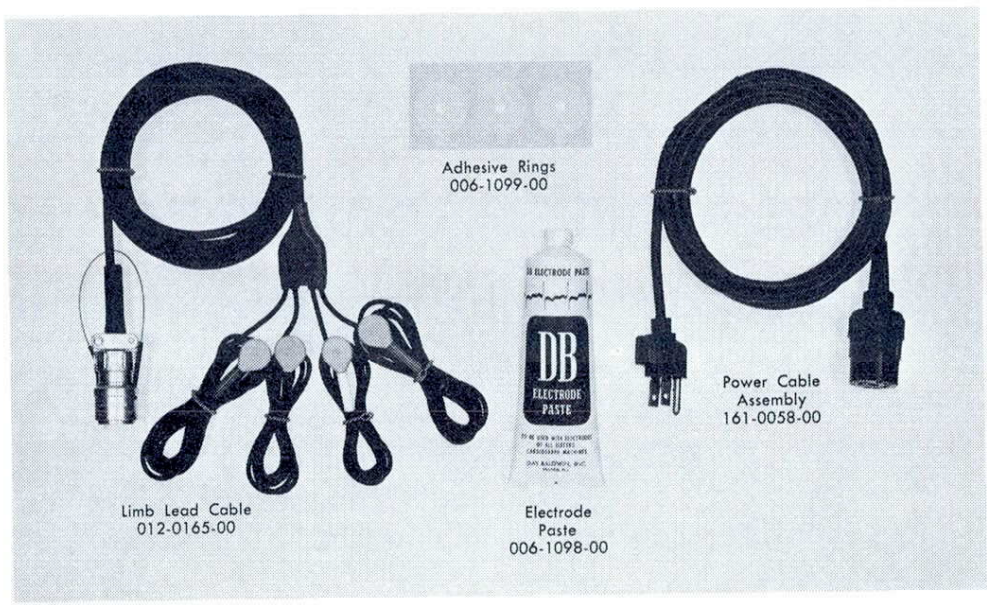
The chest lead option provides a heavy-duty chest lead cable intended for patient monitoring in an intensive care environment.



Accessories include: power cable assembly (161-0058-00); chest lead cable (012-0161-00); 3 electrodes (119-0197-00); electrode paste (006-1098-00); adhesive rings (006-1099-00); 2 instruction manuals (070-0658-00).
Order 410 MOD 950A $825

LIMB LEAD OPTION

The limb lead option provides a heavy-duty limb lead cable intended for use during surgery and in general ECG monitoring applications.



Accessories include: power cable assembly (161-0058-00); limb lead cable (012-0165-00); 4 electrodes (119-0197-00); electrode paste (006-1098-00); adhesive rings (006-1099-00); 2 instruction manuals (070-0658-00).
Order 410 MOD 950B $835

OPTIONAL ACCESSORIES

MOUNTING STAND

Mounts Type 410 at the five-foot level, permits swivelling and tipping the Monitor for convenient viewing. Hardware supplied with the fixture attaches to gas machine, bed, flat or round surface up to 1½-inch diameter.

Order 016-0110-00 ..... $ 40

MOUNTING CUP

Mounts Type 410 to flat surface, permits tipping the Monitor for convenient viewing. Mounting screws not included.

Order 407-0393-01 ..... $3.30

CHEST LEAD CABLE PACKAGE

Patient cable with 3 electrodes installed, electrode paste and rings.

Order 012-0183-00 ..... $ 75

LIMB LEAD CABLE PACKAGE

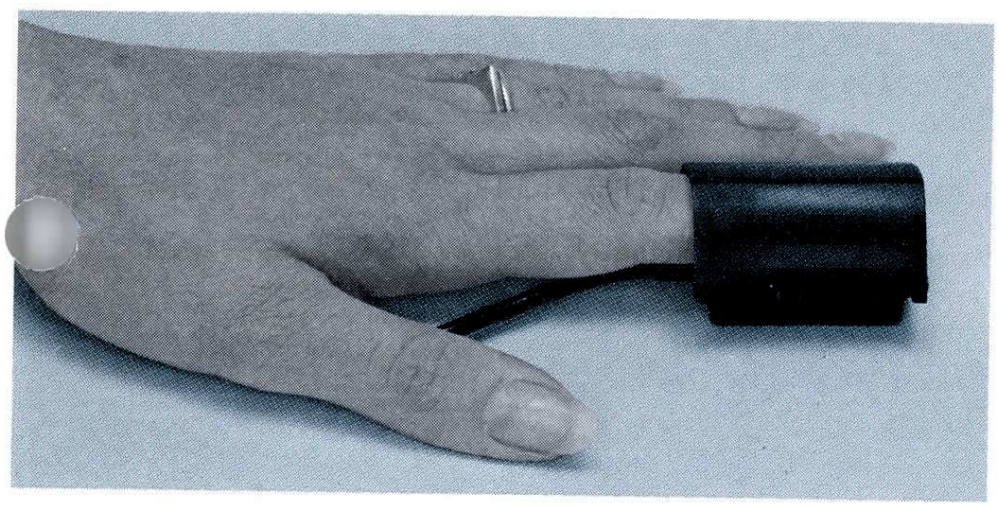
Patient cable with 4 electrodes installed, electrode paste and rings.

Order 012-0184-00 ..... $ 85

PATIENT CABLE PACKAGE

Same as standard accessory package less power cord and manuals.

Order 012-0185-00 ..... $125



PULSE SENSOR ASSEMBLY (PLETHYSMOGRAPH)

Photoresistive sensor for pulse measurements, used with Type 410 Auxiliary input.

Order 015-0104-00 ..... $ 66

BATTERY PACK

Extra battery pack, in addition to the one supplied with the Type 410, allows one pack to charge while the other is powering the Monitor. Pack contains 10 size "C" NiCd cells and battery charger.

Order 016-0107-02 (For SN B100000 and ABOVE) $140

Order 050-0478-00 (For SN B099999 and BELOW) $146

EEG ELECTRODES

Minus EEG Electrode, order 012-0121-23 ..... $11.50

Plus EEG Electrode, order 012-0121-24 ..... $11.50

BARE WIRE ADAPTER

Order 103-0080-00 ..... $ 3.40

PLUGS

Mini-phone plug for audio output jack.

Order 134-0079-00 ..... $ .55

7-pin connector for rear-panel output.

Order 131-0551-01 ..... $15.50

2-pin electrode plug, order 134-0089-00 ..... $ 2.30

7-pin pulse sensor plug, order 134-0090-00 ..... $ 3.50

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Engine Analyzer Reference Information

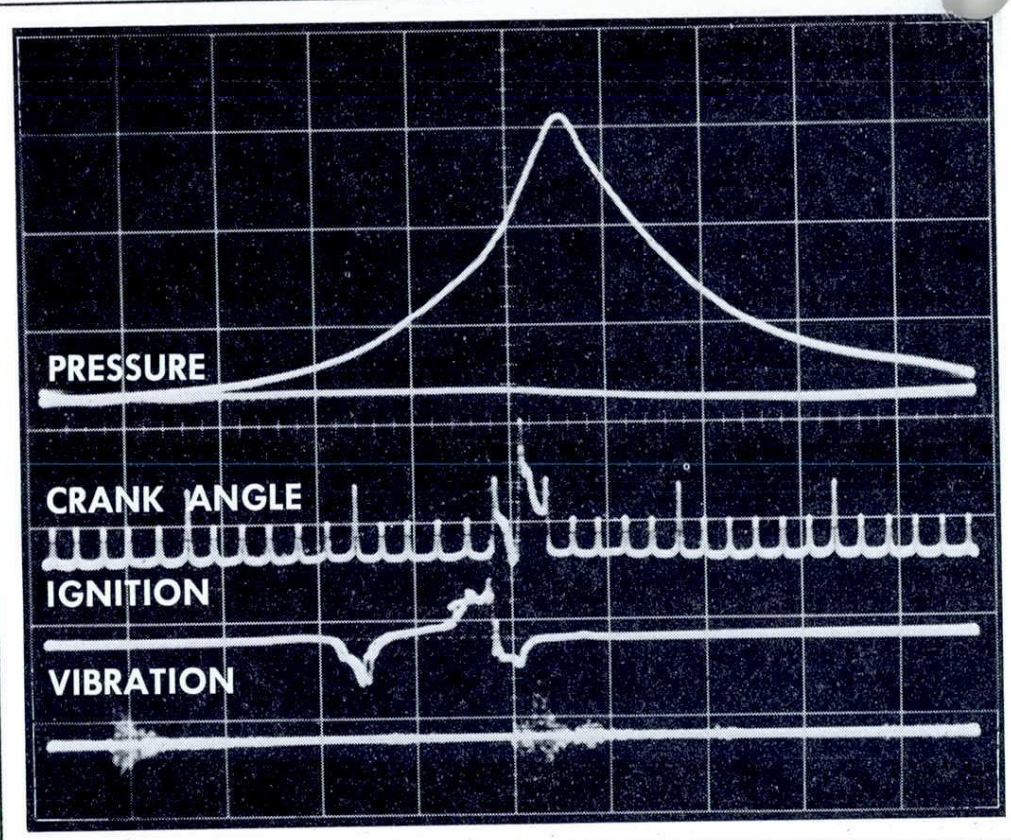
The Tektronix Engine Analyzer is designed to eliminate guesswork in locating possible failures in gas and diesel engines and compressors. The over-all performance of the engine can be determined by measuring engine parameters such as cylinder combustion pressure, vibration, ignition, timing and indicated horsepower. When used in conjunction with a preventive maintenance program, the Engine Analyzer can substantially reduce maintenance costs and increase engine and compressor life and efficiency.

The Engine Analyzer detects and locates malfunctions such as faulty ignition, timing, faulty valves, blowby, and broken or frozen piston rings. Damaged bearings, low compression pressures and other failures that impair the performance of the engine are also indicated on the oscilloscope. With the use of the Rotational Function Generator and pressure transducer, the engine horsepower can be calculated.

The Tektronix Engine Analyzer consists of a Type 561B Oscilloscope or Type 564B Storage Oscilloscope, a specially designed Type 2B67 Engine Analyzer Time Base with a Rotational Function Generator input, and a Type 3A74 Engine Analyzer Amplifier featuring four channels, with separate inputs for pressure, ignition, vibration, and crank-shaft rotation markers.

The Engine Analyzer Accessories package includes a Rotational Function Generator, pressure transducers, vibration transducers, ignition pickoff, magnetic pickup, cables and an accessory carrying case. Optional accessories include a Polaroid* Trace-Recording Camera, Scope-Mobile® Cart and a tripod for easy mounting of the Rotational Function Generator.

FOUR SIMULTANEOUS DISPLAYS



Simultaneous displays of four engine parameters provide the operator with one comprehensive picture of the total engine performance and make identification of malfunctions easy. The top waveform is engine pressure; waveform 2 shows crank-angle markers with the larger marker in the center indicating the top dead center; waveform 3 is engine ignition; waveform 4 is engine vibration showing valves opening and closing and vibration due to combustion.

VIBRATION MEASUREMENTS

Vibration measurements are useful in detecting leaking valves, destructive detonation, excessive cylinder wear, blowby, worn bearings, broken compression rings, valve flutter and many other signs of wear and malfunction. The vibration pickup is a piezoelectric crystal mounted in a magnetic head that can be placed anywhere on the engine or compressor.

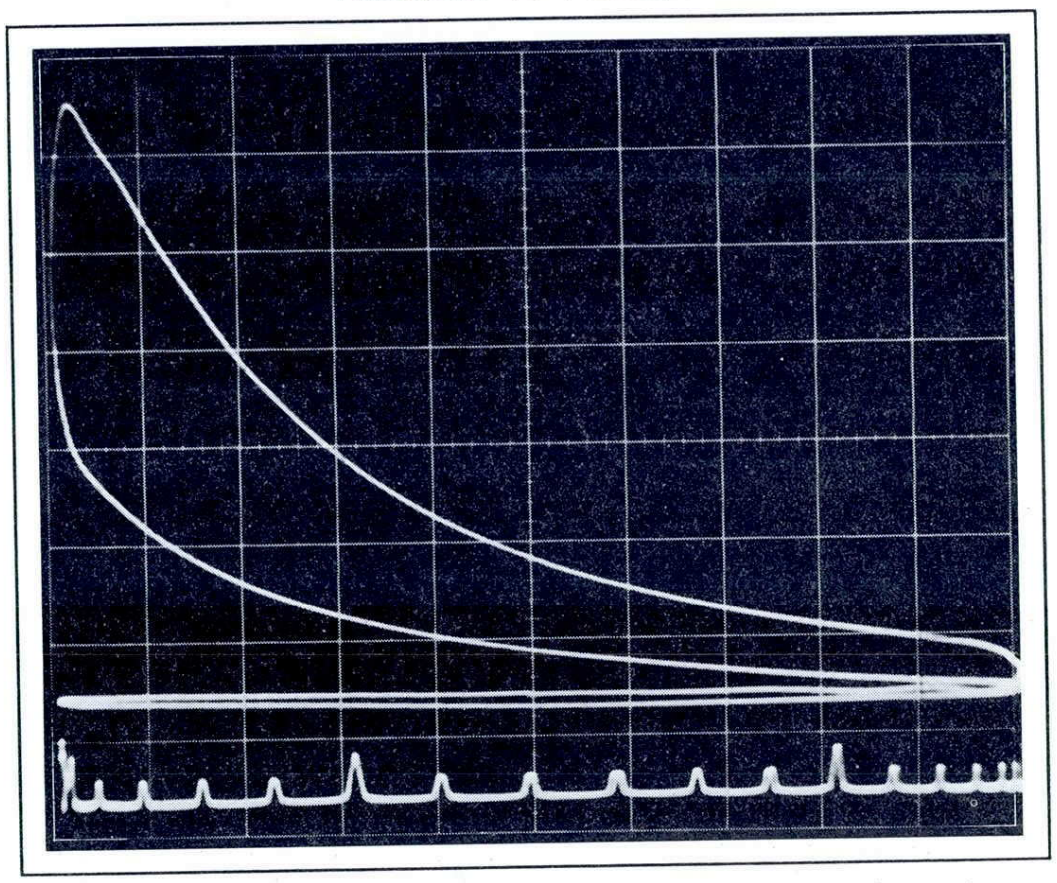
IGNITION MEASUREMENTS

Ignition measurements are used for proper timing of the engine and can detect bad spark plugs, pulse generator problems, point problems, bad condensers and coil condition. Ignition measurements can also be used to calculate RPM. Ignition measurements are made using a 1000:1 capacitive attenuator that clamps on the secondary coil and spark-plug wire.

PRESSURE MEASUREMENTS

Pressure measurements detect peak firing pressures, compression, early and late cylinder firing, and pre-ignition of the engine under test. Three displays of cylinder pressure are easily and quickly obtained: pressure vs crank angle, pressure vs cylinder volume and pressure vs time.

PRESSURE VS VOLUME



Pressure vs cylinder volume displays are used to determine the indicated engine horsepower and detect over-all problems in engines and compressors. The area within the loop is the mean effective pressure and is used to determine indicated horsepower of the engine.

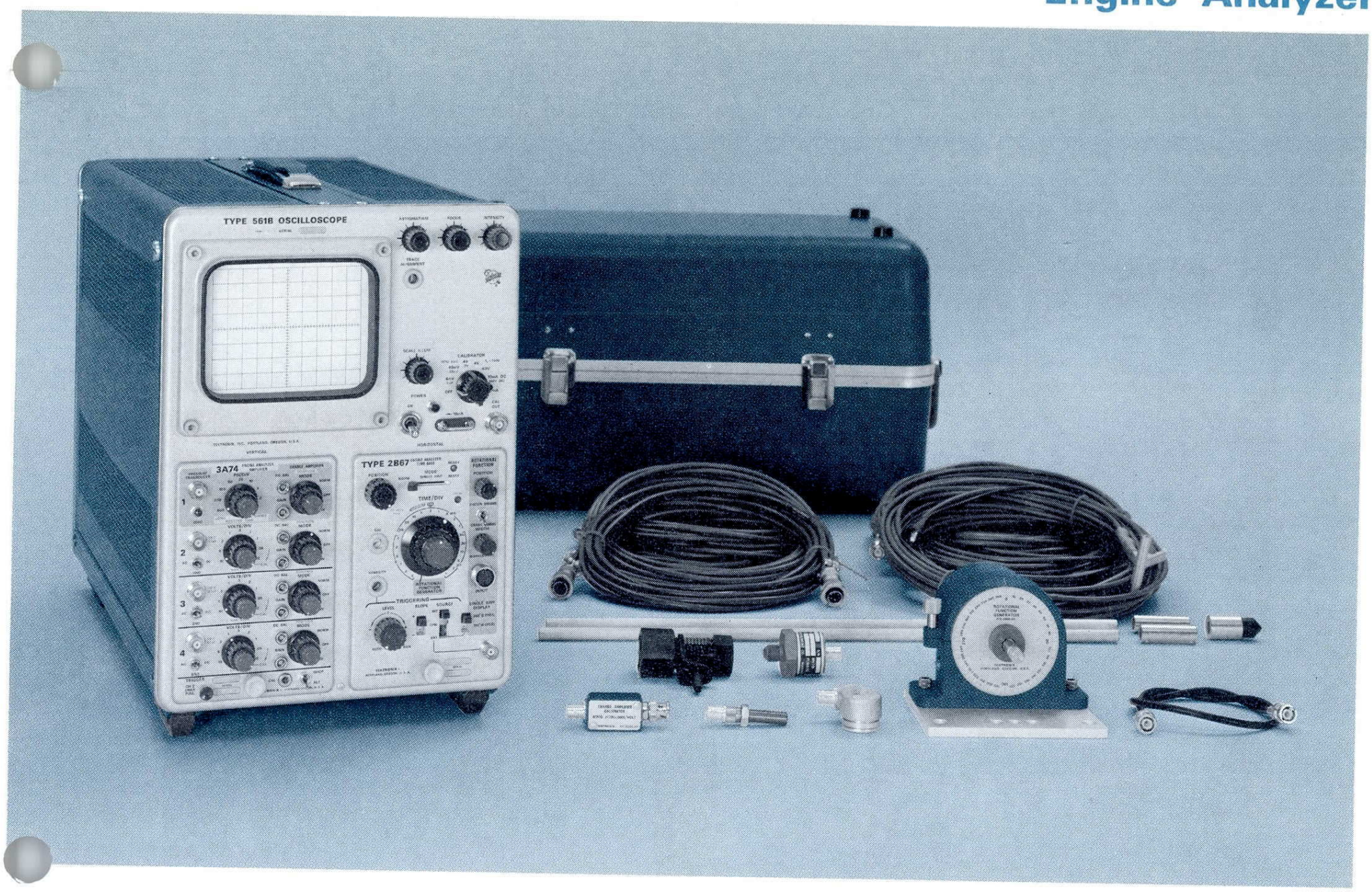
$$hp = \frac{PLAN}{33{,}000}$$

hp = Horsepower

P = Mean Effective Pres
L = Piston Stroke (ft)
A = Piston Area (in^2)
N = Engine RPM

*Registered Trademark, Polaroid Corporation

Engine Analyzer



- ***ELIMINATES GUESSWORK***
- ***REDUCES MAINTENANCE COSTS***
- ***DETECTS MALFUNCTIONS***
  - ***FAULTY IGNITION***
  - ***FAULTY VALVES***
  - ***BLOWBY***
  - ***DAMAGED RINGS***
  - ***DAMAGED BEARINGS***
  - ***DAMAGED CYLINDER LININGS***
- ***MEASURE AND DISPLAY***
  - ***PRESSURE VS VOLUME***
  - ***PRESSURE VS CRANK ANGLE***
  - ***PRESSURE VS TIME***
  - ***ENGINE VIBRATION***
  - ***ENGINE IGNITION***
- ***CRANK-ANGLE MARKERS***

ENGINE ANALYZER CHARACTERISTICS

TYPE 561B OSCILLOSCOPE

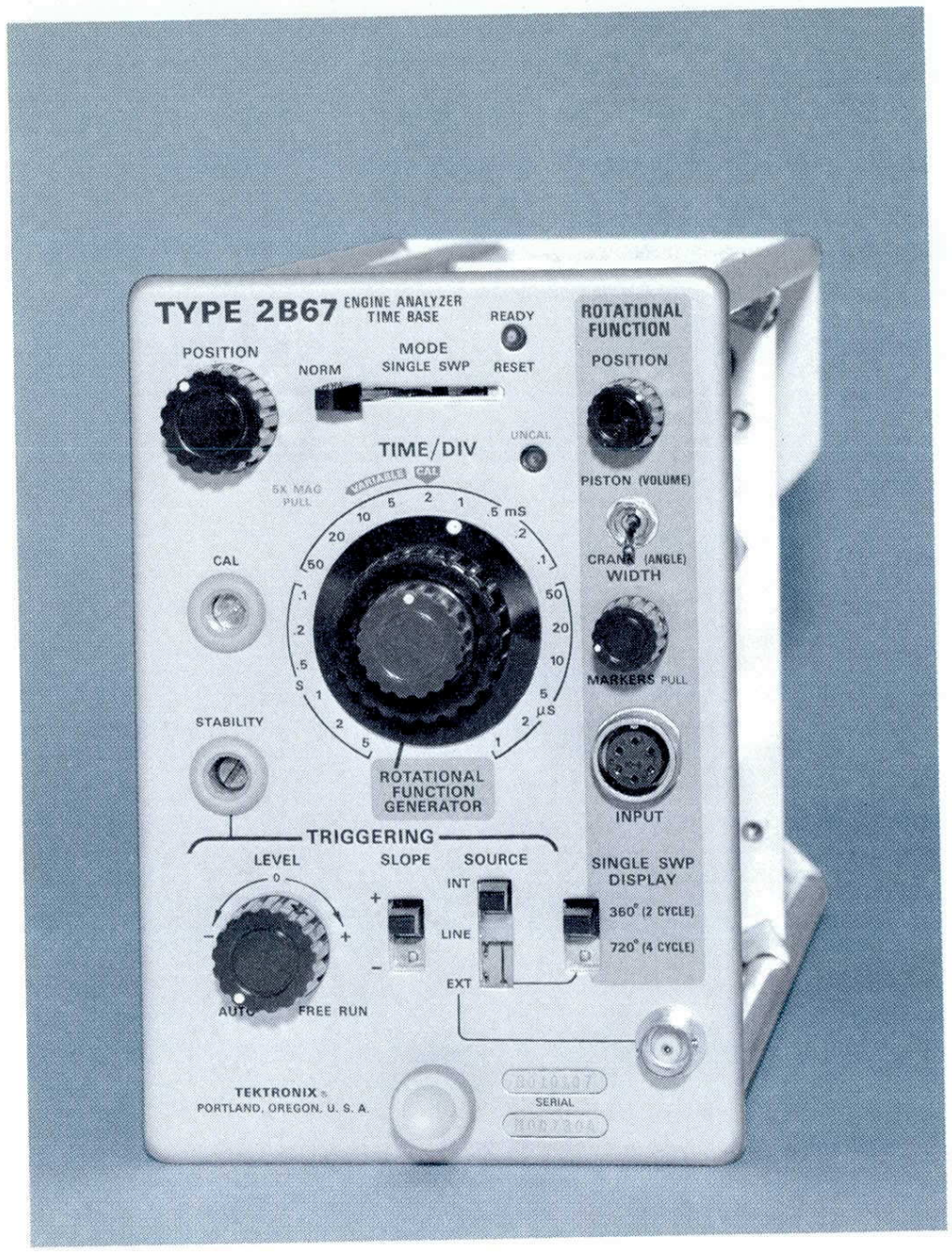
The Type 561B Oscilloscope accepts the Type 2B67 Engine Analyzer Time-Base Plug-In and the Type 3A74 Engine Analyzer Amplifier Plug-In plus all two-series and three-series Tektronix plug-in units. The Type 561B uses an 8 x 10-cm cathode-ray tube that features an internal, illuminated graticule. An amplitude and time calibrator provides accurate squarewave voltages from 4 mV to 40 V P-P.

TYPE 564B STORAGE OSCILLOSCOPE

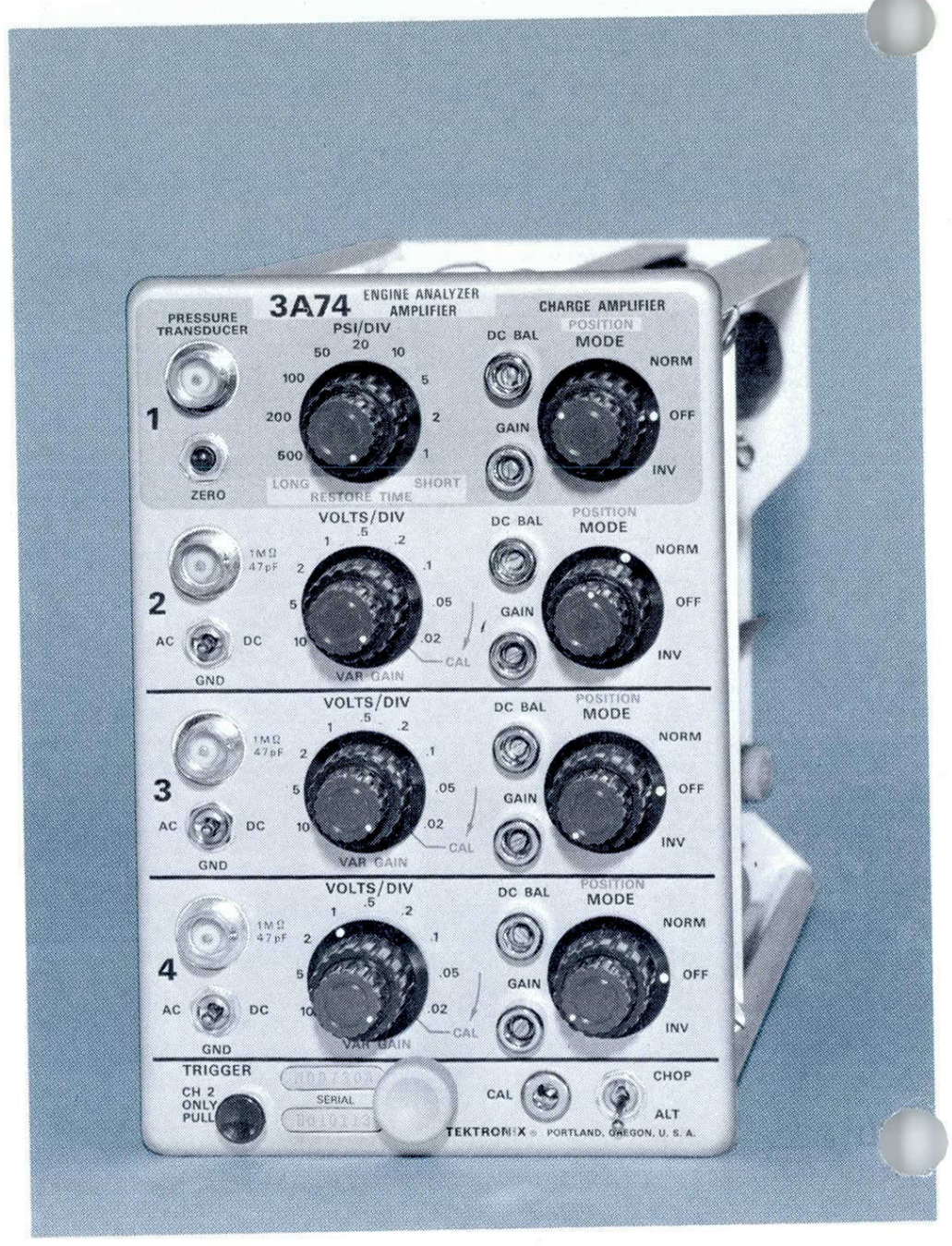
The Type 564B Storage Oscilloscope uses the same plug-in units as the Type 561B and offers the added advantage of split-screen storage. Split-screen storage permits using either half of the display for storage and/or conventional displays. Storage is especially useful when making pressure measurements. 10 or 20 engine cycles can be stored on the display to detect changes of pressure, or the display can be continuously stored for up to one hour to detect pre-ignition problems.

Engine Analyzer

TYPE 2B67 ENGINE ANALYZER TIME BASE



TYPE 3A74 ENGINE ANALYZER AMPLIFIER



TIME BASE

1 μs/div to 5 s/div and 21 calibrated steps, 1-2-5 sequence; accurate within 3%. 5X magnifier operates over full time base, accurate within 5%.

SINGLE SWEEP

Provides single display for one-shot waveform photography and storage applications. In the Rotational Function Generator mode of operation, single displays of either 360° (2 cycle) or 720° (4 cycle) are possible.

TRIGGER

Automatic, manual, or free-run operation; triggering on + or — slope from an internal, line frequency or external source. In external trigger, a signal from the Rotational Function Generator is available for triggering.

ROTATIONAL FUNCTION AMPLIFIER

Accepts inputs from the Rotational Function Generator providing horizontal displays of piston volume or crank angle. Crank-angle degree markers are internally coupled to Channel 2 of the Type 3A74 Engine Analyzer Amplifier.

The Type 3A74 Engine Analyzer Amplifier is a four-channel plug-in unit featuring simultaneous displays of pressure, crank-angle markers, engine vibration, and ignition. Channel 1 is a charge amplifier designed for use with the pressure transducer; Channel 2 provides a crank-angle marker display from the Rotational Function Generator plus the magnetic pickup display of top dead center; Channel 3 and Channel 4 are identical amplifiers used for vibration and ignition displays.

CHARGE AMPLIFIER, CHANNEL 1

1 psi/div to 500 psi/div in 1-2-5 sequence; accurate within 3%. Frequency response: Restore Time — Long is from 0.05 Hz to 10 kHz, Short is from 0.5 Hz to 10 kHz. Maximum charge signal is 0.6 μC (micro coulomb) at 10 kHz, increasing to 2 μC at 2.75 kHz. Restore Time is at least 3 s in the Long position, at least 0.3 s in the Short position. Display noise is less than 0.15 pC (pico coulomb) per 1000 pF of source capacitance, with 1 psi/div and gain set to 100 pC/psi.

CHANNELS 2, 3 and 4

0.02 V/div to 10 V/div in 9 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div. Bandwidth is DC to 2 MHz at 3-dB down. AC-coupled low-frequency response is 2 Hz. Input characteristics are 1 MΩ paralleled by approx 47 pF. Maximum input voltage is 600 V (combined DC plus AC).

ENGINE ANALYZER ACCESSORIES

PRESSURE TRANSDUCER
(015-0117-00)

The Pressure Transducer is designed for use at engine speeds up to 6000 RPM, providing thread temperature is limited to 150° C. Engine speed must be derated to 1500 RPM when using the cooling adapter and to 1000 RPM when a 5-inch to 10-inch coupling pipe is used. The piezoelectric Pressure Transducer, when used with the charge amplifier of the Type 3A74 Engine Analyzer Amplifier and the included 50-ft low-noise cable, has the following characteristics.

PRESSURE RANGE is 0 to 3000 psi.

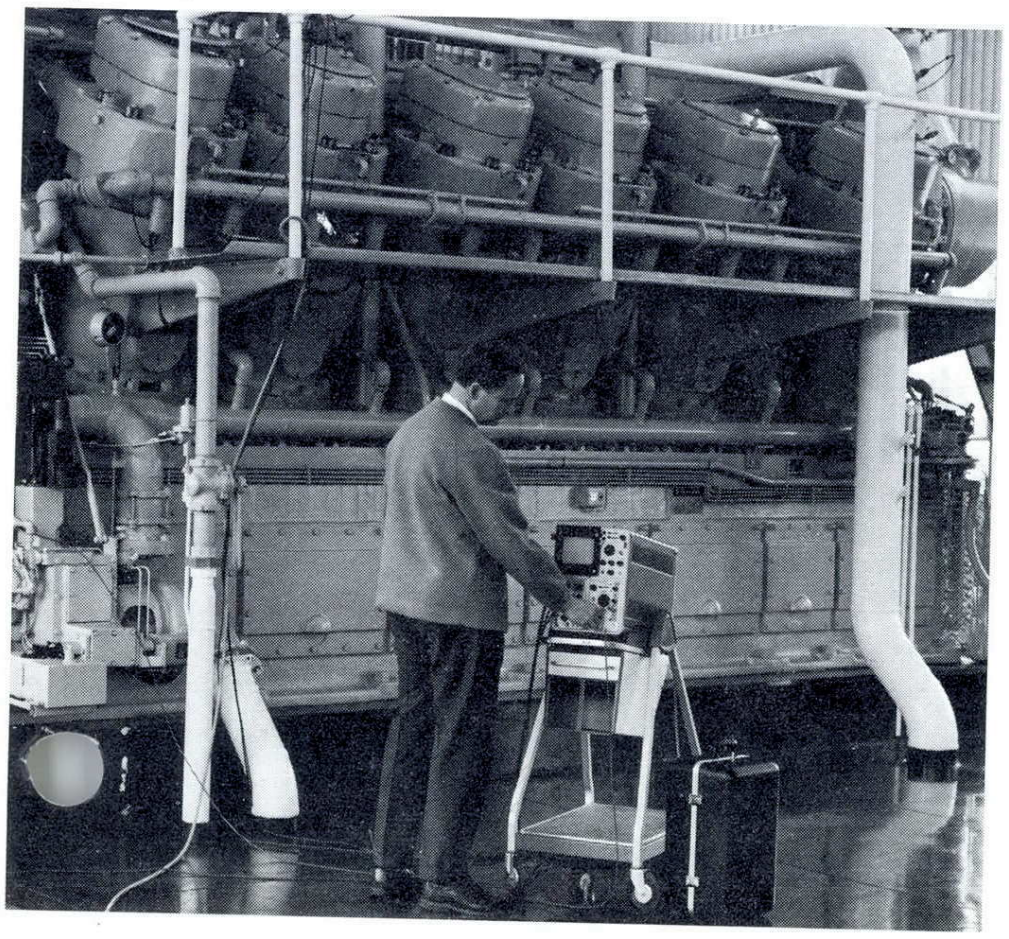
DEFLECTION FACTOR is 1 psi/div to 500 psi/div in 1-2-5 sequence, accurate within 5% throughout calibrated range. Maximum overload pressure is 300%.

BANDWIDTH in the Long Restore Time position is from 0.05 Hz or less to at least 10 kHz; in the Short Restore Time position, from 0.5 Hz or less to at least 10 kHz.

RESTORE TIME in the Long position is at least 3 seconds; in the Short position is at least 0.3 seconds.

NOISE is not discernible with the 50-ft low-noise cable supplied.

TEMPERATURE RANGE is from —40°C to +150°C. A cooling adapter is supplied for environmental conditions above +150°C.



VIBRATION TRANSDUCER
(015-0116-00)

The piezoelectric Vibration Transducer has a magnetic mount and is used with Channel 2, 3 or 4 of the Type 3A74 Engine Analyzer Amplifier with the included 50-ft low-noise cable.

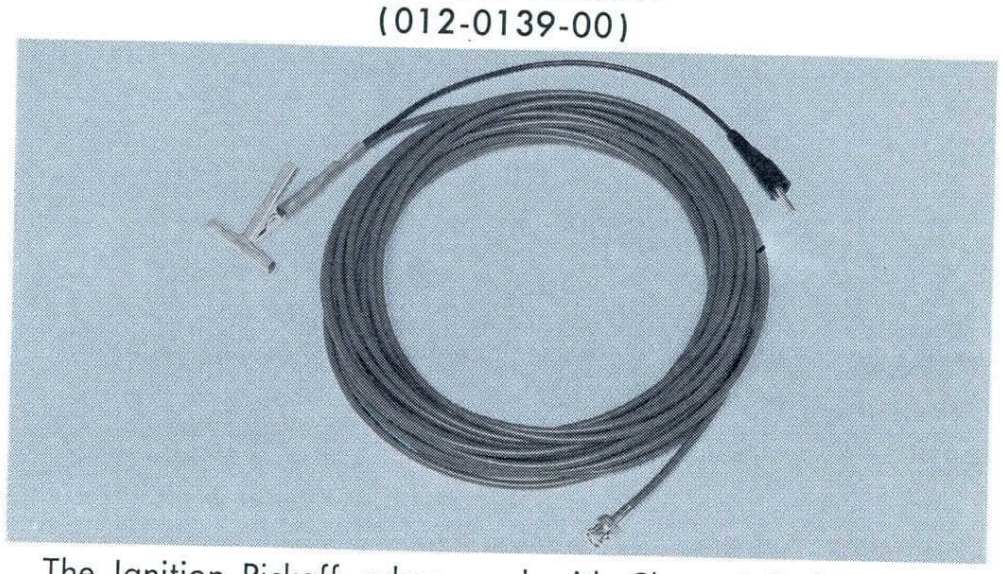
TRANSDUCER SENSITIVITY is nominally 6 mV/g (4.5 mV/g with the included cable). Exact value is shown with the calibration chart supplied with the transducer.

BANDWIDTH is from 40 Hz to 15 kHz with a resonant frequency at approx 10 kHz.

MAXIMUM ACCELERATION is 1000 g's.

TEMPERATURE RANGE is from —40°C to +150°C.

IGNITION PICKOFF
(012-0139-00)



The Ignition Pickoff, when used with Channel 2, 3 or 4 with the Type 3A74 Engine Analyzer Amplifier and the included 50-ft low-noise cable, has the following characteristics.

ATTENUATION is nominally 1000:1. Exact attenuation is determined by the capacitance between the pickoff and the secondary lead under test. The oscilloscope calibrator and a piece of ignition cable can be used to calibrate the ignition pickoff and the vertical amplifier.

TIME CONSTANT is at least 6.5 ms.

MAGNETIC PICKUP
(015-0119-00)

The Magnetic Pickup, when used with Channel 2 of the Type 3A74 Engine Analyzer Amplifier and the included 20-ft or 50-ft low-noise cable, has the following characteristics.

OUTPUT VOLTAGE is at least 15 V P-P at 1000 inch/s and a clearance gap of 0.005 inch using a 20-pitch, 30-tooth ferrous metal gear.

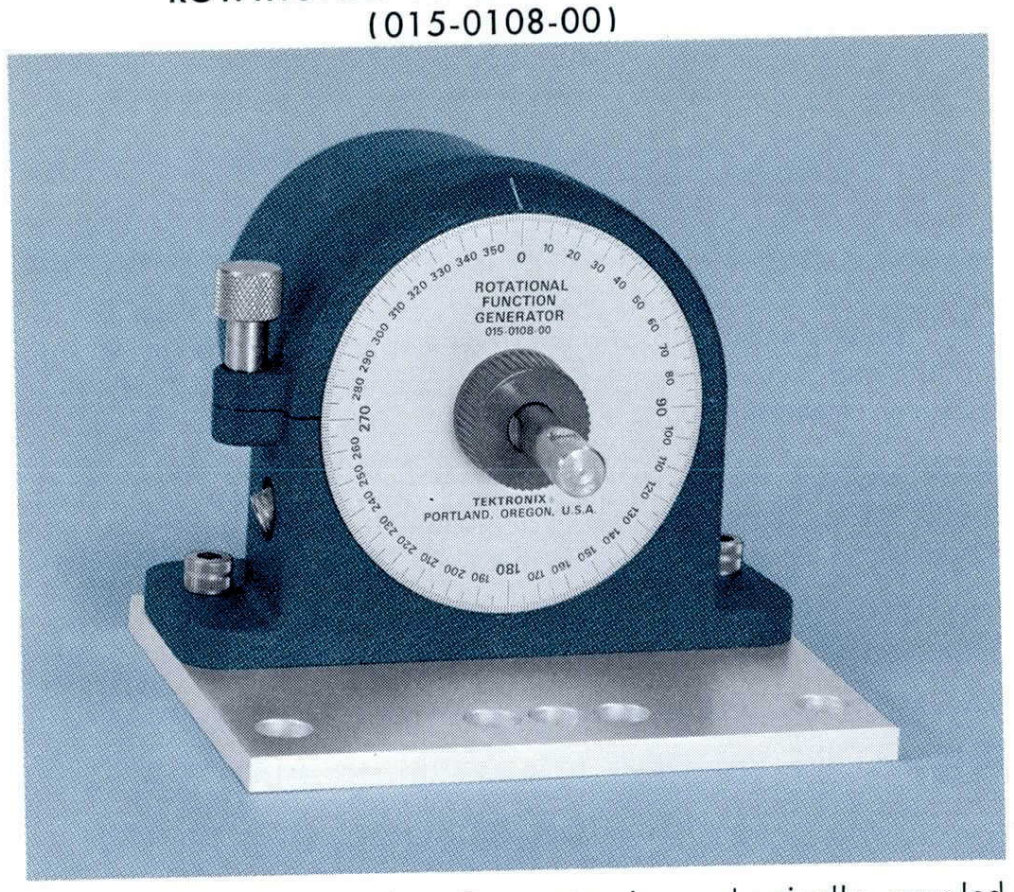
COIL RESISTANCE is 90 Ω to 110 Ω.

COIL INDUCTANCE is 26 mH to 40 mH.

TEMPERATURE RANGE is from —54°C to +107°C.

Engine Analyzer

ROTATIONAL FUNCTION GENERATOR (015-0108-00)



The Rotational Function Generator is mechanically coupled to the engine under test and generates 10°, 60° and 360° markers. Crank-Angle Markers are displayed on Channel 2 of the Type 3A74 Engine Analyzer. The Rotational Function Generator is mechanically timed to an engine reference point by comparing the display of the top dead center mark of the magnetic pickup from the fly wheel with the 0°/360° pulse generated by the function generator. The Rotational Function Generator also generates a sawtooth ramp for displays related to crank angle, and a waveform that is equivalent to piston volume for P-V curves. The Rotational Function Generator, when used with the Type 2B67 Engine Analyzer Time Base and the included 20-ft cable supplied, has the following characteristics.

MAXIMUM RPM is 20,000 revolutions per minute.

DEGREE MARKER angular accuracy is within 1°.

SHAFT LOAD axial and radial is 10 lb maximum.

CRANK-ANGLE MARKERS are generated every 10°, a pulse of larger amplitude every 60°, and a pulse riding on a pedestal every 360°. The markers are internally coupled to Channel 2 and have an amplitude of at least a division of the display. The magnetic pickup signal can be superimposed on Channel 2 to permit timing of the function generator markers to the engine under test.

CRANK ANGLE displays provide 350° of useable display related directly to crank angle; incremental accuracy is within 3% of full scale display.

PISTON VOLUME displays have an incremental accuracy within 3% of full scale display. The phase shift is 0.5° or less at 20,000 RPM.

TEMPERATURE RANGE is from —15°C to +75°C.

ORDERING INFORMATION

TYPE 561B P7 OSCILLOSCOPE, without plug-in units **$ 5**

OR

TYPE 564B STORAGE OSCILLOSCOPE, without plug-in units **$1095**

TYPE 2B67 ENGINE ANALYZER TIME BASE, order Type 2B67 MOD 730A ..... **$ 410**
Includes: Engine Analyzer instruction manual (070-0890-00).

TYPE 3A74 ENGINE ANALYZER AMPLIFIER, order Type 3A74 MOD 730A ..... **$ 850**
Includes: Engine Analyzer instruction manual (070-0890-00).

ENGINE ANALYZER ACCESSORY PACKAGE
Order 015-0126-00 ..... **$ 900**

Includes: rotational function generator (015-0108-00); pressure transducer (015-0117-00); vibration transducer (015-0116-00); magnetic pickup (015-0119-00); ignition pickoff (012-0139-00); 20-ft function generator cable (012-0140-00); adapter plate (386-1453-00); extension shaft kit (015-0124-00); cooling adapter (015-0118-00); 3 50-ft low-noise coax cables (012-0137-00); 20-ft low-noise coax cable (012-0136-00); clip marker cable kit (016-0127-00); 18-inch coax cable (012-0076-00); charge amplifier calibrator (011-0095-00); carrying case/trays (202-0170-01); instruction manual (070-0890-00).

For price and availability information on specific items included in the Engine Analyzer accessory package, contact your nearby Tektronix Field Office.

RECOMMENDED OPTIONAL ACCESSORIES

CAMERAS

C-12 with beam-splitting mirror for straight-on viewing and use of optional projected graticule, f/1.9—1:0.85 lens, Polaroid Land* Pack Film back, order C-12 ..... $490

Type 561B or Type 564B to C-12 Camera adapter, order 016-0217-00 ..... $ 16

Projected Graticule for 115 V, order 016-0204-00 .... $175

Projected Graticule for 230 V, order 016-0234-00 .... $175

Camera carrying case, order 016-0208-01 ..... $ 85

SCOPE-MOBILE® CART

Model 201-1: 9-position tilt-lock oscilloscope tray, order 201-1 ..... $145

TRIPOD

For easy mounting and positioning of the Rotational Function Generator, order 016-0253-00 ..... $ 33

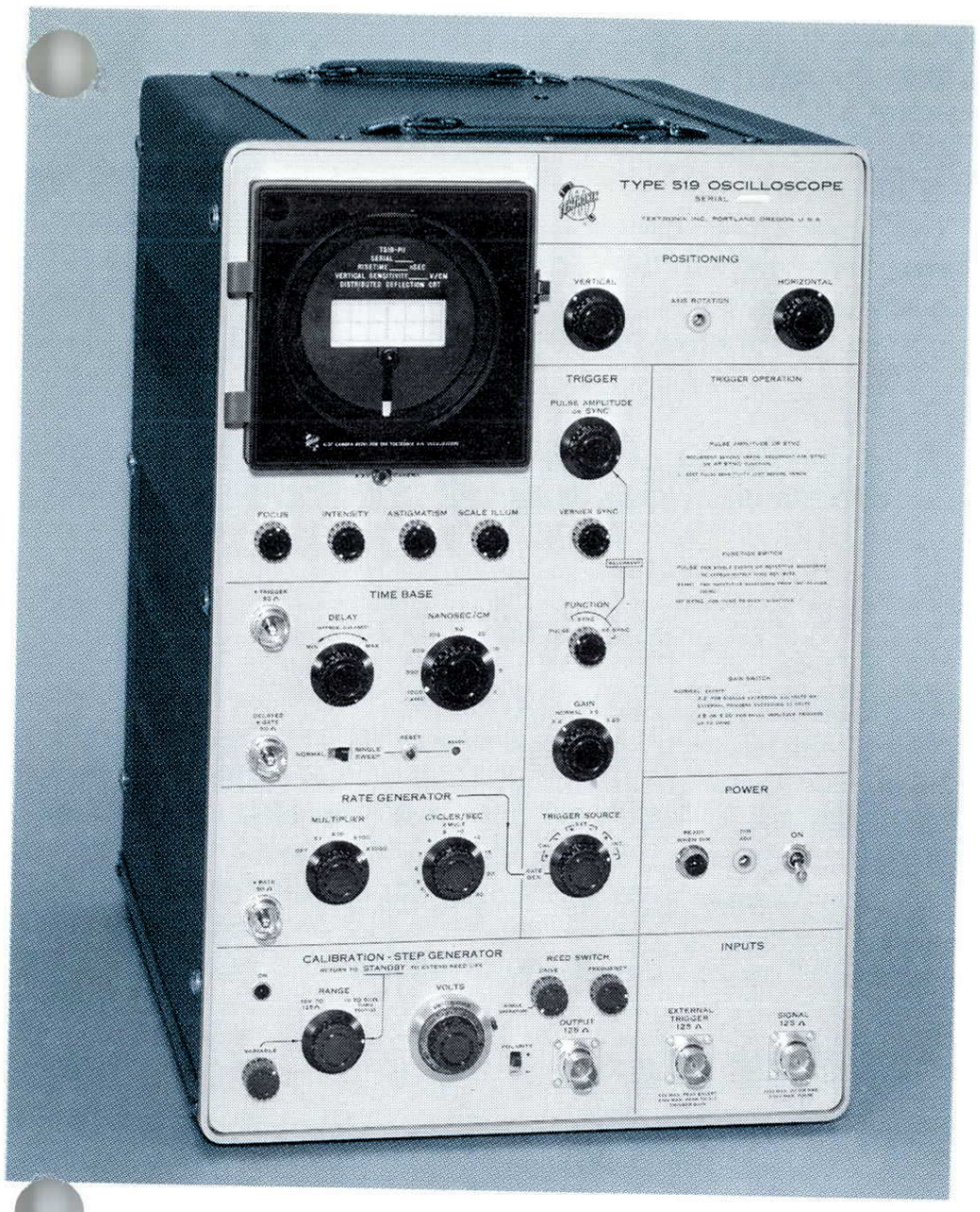
ROTATIONAL FUNCTION GENERATOR

Rotational Function Generators can be permanently attached to a number of engines for use with the Engine Analyzer when needed, order 015-0108-00 ..... $190

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

1-GHz Real-Time Oscilloscope

519



- *SINGLE-SHOT PHOTOGRAPHS AT 2 NS/CM*
- *0.004-INCH SPOT SIZE*
- *SENSITIVE WIDEBAND TRIGGER SYSTEM*
- *SYNCHRONIZATION TO OVER 1 GIGAHERTZ*
- *VSWR, 1.25, OR LESS, TO 1 GIGAHERTZ*
- *DISTRIBUTED-DEFLECTION CRT*
- *BUILT-IN DELAY LINE*

CHARACTERISTIC SUMMARY

VERTICAL

BANDWIDTH—DC to 1 GHz.

RISETIME—less than 0.35 ns.

DEFLECTION FACTOR— $\leq$10 V/cm.

INPUT IMPEDANCE—125 Ω $\pm$2%.

HORIZONTAL

CALIBRATED TIME BASE—2 to 1000 ns/cm.

SWEEP DELAY—0 to 35 ns.

CRT

DISPLAY AREA—2 x 6 cm.

ACCELERATING VOLTAGE—24 kV.

PHOSPHOR—P11.

OTHER

CALIBRATION-STEP GENERATOR—0 to 10 V into 125 Ω or 0 to 1 V into 50 Ω, calibrated and continuously variable. (ns risetime, approx.) Approximately 750-Hz repetition

POWER REQUIREMENTS—105 to 125 V or 210 to 250 V, approx 650 watts.

The Tektronix Type 519 Oscilloscope is a calibrated, high-speed, laboratory instrument designed for observation, measurement, and photographic recording of fractional nanosecond risetimes. A 2 x 6 cm viewing area, coupled with 24-kV accelerating potential, affords bright displays with excellent resolution. Performance features include: bandwidth from DC to beyond 1 gigahertz, risetime less than 0.35 ns, deflection factor $\leq$10 V/cm, linear sweeps to 2 ns/cm, sweep delay through 35 ns, and a wideband trigger system. The single unit houses a fixed signal delay line, a convenient sweep-delay control, a pulse-rate generator, a standard amplitude and waveshape generator, and regulated power supplies and high-voltage supply. Only one connection is necessary for normal operation—a connection of the signal from the device under test.

Combining simple operation with laboratory precision and reliability, the Type 519 ideally suits single-shot or random nuclear events. In addition, the bandwidth permits applications to general measurements where oscilloscope risetime must be less than signal risetime.

1-GHz Real-Time Oscilloscope

519

VERTICAL DEFLECTION

BANDWIDTH
DC to 1 GHz at 3-dB down.

RISETIME
Less than 0.35 ns.

DEFLECTION FACTOR
$\leq$10 V/cm.

INPUT IMPEDANCE
125 Ω ±2%.

MAXIMUM INPUT SIGNAL
±15 VDC or 15 V RMS, or ±100-V pulse. Maximum power input is 1.8 watts.

SIGNAL DELAY
45 ns approx. Permits viewing of leading edge of triggering waveform.

HORIZONTAL DEFLECTION

TIME BASE
2 ns/cm to 1000 ns/cm in 9 calibrated steps (1-2-5 sequence), accurate within 3%.

SWEEP DELAY
Sweep start delayed 0—35 ns.

SINGLE SWEEP
After a single sweep is generated, the sweep circuit is locked out until the RESET button is pressed then sweep fires on next trigger. An external jack is provided for remote control of single sweep operation.

SYNCHROSCOPE OPERATION
The output signal from either the +TRIGGER 50 Ω, the DELAYED +GATE 50 Ω, or the +RATE 50-Ω connector can be used to control an external device.

RATE GENERATOR
Output pulse approx 15 V, risetime $\leq$ 0.8 ns, duration approx 10 ns. Repetition rate variable between 3 Hz and 30 kHz.

TRIGGER

MODES
Pulse—Permits choice of a free-running sweep or a stable sweep which can be triggered on random or uniform repetition rates up to approx 50 MHz.
Sync—Permits stable displays of signals occurring at a constant repetition rate to over 100 MHz.
HF Sync—Permits the sweep to be synchronized with signals from approx 100 MHz to over 1 GHz.

SOURCES
Internal, external, calibration-step generator, or rate generator.

REQUIREMENTS
Two trace widths vertical deflection and 1 ns or greater duration (Internal) or 20 mV or greater amplitude and 1 ns or greater duration (External). Sweep triggers on either the positive or negative slope of the triggering signal.

TRIGGER GAIN
Four gain settings of X0.2, NORMAL, X5, and X20 provide for attenuation or amplification of trigger signals.

MISCELLANEOUS

CALIBRATION STEP GENERATOR
A step-waveform of approximately 750-Hz repetition rate, with amplitude continuously variable and calibrated from 0 to 10 V into 125 Ω, or 0 to 1 V into 50 Ω (through a T50/T125 adapter) is available at a front-panel 125-Ω connector. Risetime is approximately 0.1 ns and either polarity can be selected. Continously variable uncalibrated amplitudes of 0 to 50 V into 125 Ω are also available.

CATHODE-RAY TUBE
5-inch round, flat-faced tube. 24-kV accelerating potential. Maximum x-radiation at a distance of five centimeters from any external surface of the 519 does not exceed 0.5 milliroentgens per hour under any conditions of normal operation obtained with any adjustment of front panel controls. Supplied with P11 phosphor.

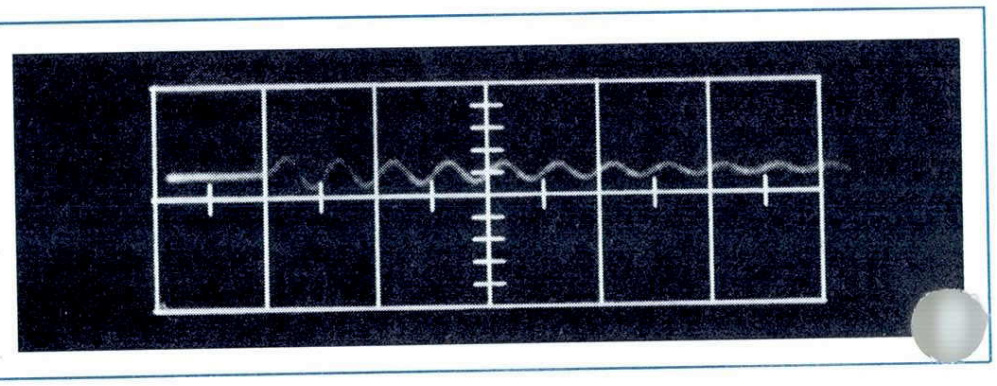
GRATICULE
Edge-lighted, 2-cm by 6-cm divisions. The horizontal center line markings are 5 mm apart and the vertical center line markings are 2 mm apart. Illumination is controlled by a front-panel knob. The graticule can be dropped out of view if desired.

CAMERA MOUNTING
A special camera-mounting adapter with swing-away hinging easily accepts a Tektronix C-27-662R Camera. Please refer to the Camera Section for complete description.

POWER REQUIREMENTS
105 V to 125 V or 210 V to 250 V, 50 to 60 Hz, typically 650 watts. Factory wired for 105 V to 125 V. May be ordered wired for 210-V to 250-V operation.

SINGLE-SHOT PHOTOGRAPHY

A single-shot exposure using a Type C-27-662R Camera was used to take the picture at the right. The display shows a ≈1-GHz damped wave at 2 ns/cm. The waveform was enlarged 2 times to represent the actual size of the CRT display.



1-GHz Real-Time Oscilloscope

519

DIMENSIONS AND WEIGHTS

Height	22¼ in	56.5 cm
Width	14⅝ in	37.2 cm
Depth	25¼ in	64.1 cm
Net weight	97 lb	44.1 kg
Domestic shipping weight	≈130 lb	≈59 kg
Export-packed weight	≈169 lb	≈77 kg

INCLUDED STANDARD ACCESSORIES

Viewing hood (016-0001-01); two 125-Ω terminations (017-0051-00); two 125-Ω insertion units (017-0013-00); 125-Ω coupling capacitor (017-0018-00); 125 Ω 1-GHz timing standard (017-0019-00); Double-button contact assembly (017-0032-00); Panel adapter assembly (017-0033-00); Cable connector (017-0035-00); 125-Ω min loss attenuator, T50/T125 (017-0052-00); 125-Ω adapter N50/N125 (017-0053-00); 125-Ω adapter, T50/N125 (017-0055-00); Delay-line equalizer (017-0057-00); 1-ns cable (017-0507-00); 2-ns cable (017-0508-00); 5-ns cable (017-0509-00); 10-ns cable (017-0510-00); 3 to 2-wire adapter (103-0013-00); Phone jack plug (134-0069-00); 3-conductor power cord (161-0010-03); Walnut box (202-0083-00); Two reed switches (260-0693-00); Accessory box tray (436-0030-00); Two instruction manuals (070-0243-00).

TYPE 519 OSCILLOSCOPE $4650

OPTIONAL ACCESSORIES

Optional accessories serve to extend the usefulness of the Type 519 in certain applications. This listing covers only the more commonly used items. The termination, cables, and adapters supplied with the instrument satisfy most measurement requirements. A complete list of accessory items can be found in the catalog accessory pages.

ATTENUATORS, ADAPTERS, AND CABLES

125-Ω 2:1 attenuator, order 017-0071-00 ..... $33.00
125-Ω 5:1 attenuator, order 017-0049-00 ..... $33.00
125-Ω 10:1 attenuator, order 017-0050-00 ..... $33.00
125-Ω adapter N50/T125, order 017-0054-00 ..... $20.00
125-Ω 90° elbow assembly, order 017-0043-00 ..... $18.25
125-Ω 20-ns cable, order 017-0511-00 ..... $20.00

SCOPE-MOBILE® CART

Provides portability between various operating areas and serves as a convenient working surface for Type 519, order Model 202-1, Mod 52 ..... $185.00

CAMERA

Ultra-high writing rate—f1.3, 1:0.5—Polaroid* Roll-Film back, order C-27-662R $635.00

*Registered Trademark, Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Direct-Reading L-C Meter

130

- ***MEASURES UP TO 300 μH OR 300 pF***
- ***EASY-TO-READ 4½-INCH METER***
- ***CONVENIENT OPERATION***

The Type 130 L-C Meter is a direct-reading reactance meter that measures small reactances in a series mode at a frequency between 125 kHz and 140 kHz. Meter indicates inductance up to 300 μH and capacitance up to 300 pF. The unknown inductor or capacitor is part of a resonant circuit whose frequency is compared to a 140-kHz reference oscillator. Meter indicates the two oscillator's frequency difference but is calibrated directly in μH and pF. Measurement of very small reactances is possible by using special measurement procedures that are described in the instrument instruction manual.

The Type 130 is particularly useful for measuring small capacitances in the presence of environmental strays. A front-panel Guard Voltage output connector provides in-phase drive to the environmental capacitance to eliminate strays from the measurement. Thus it is possible to measure vacuum tube interelectrode capacitances. Up to 300 pF environmental capacitance around an unknown capacitor can be guarded if the guard terminal loading is not excessive. Loading limits are outlined in the instruction manual.

Resistance loading compensation is optimized for 117-volts RMS operation. The following loads will not appreciably alter the measurement indication:

Capacitance: as low as 100-kΩ shunt.
Inductance: as low as 20-kΩ shunt, up to 10-Ω series.
Correction tables in instruction manual indicate needed corrections for other values of load resistance. Actual corrections determined for each instrument at time of each recalibration.

RANGE SELECTION

Microhenrys—0 to 3, 10, 30, 100, and 300.
Picofarads—0 to 3, 10, 30, 100, and 300.

ACCURACY

Meter indicates within 3% of full scale. Full scale accuracy of any one range can be improved by special calibration at the time measurement is made.

POWER REQUIREMENTS

40 watts, 50 to 60 Hz. Instrument factory wired for 105 V-to-125 V (117 V nominal) operation. Transformer taps permit operation at 210 V to 250 V (234 V nominal). Instrument can be ordered factory wired for 210 V to 250 V operation.

DIMENSIONS AND WEIGHTS

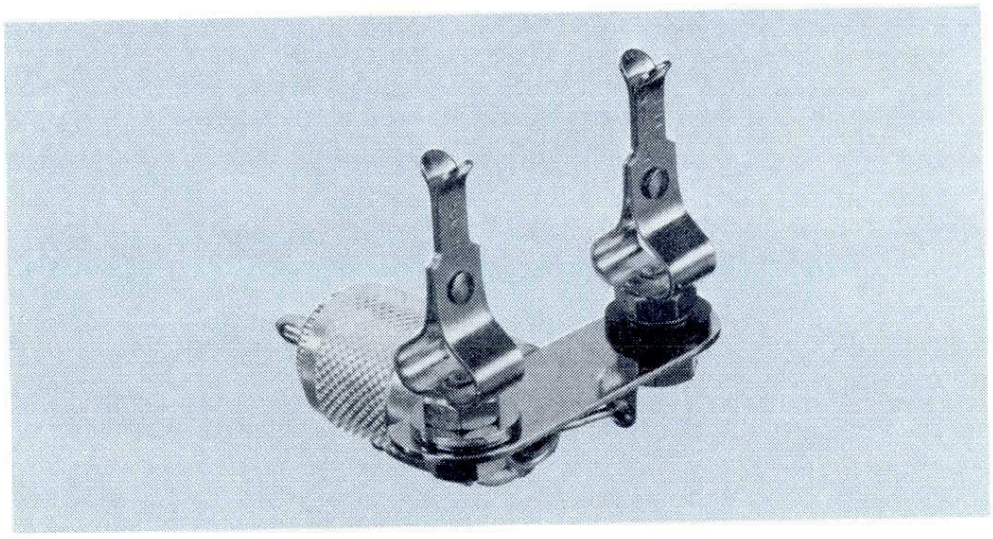
Height	10⅝ in	27.0 cm
Width	7 in	17.8 cm
Depth	11⅛ in	28.3 cm
Net weight	9 lb	4.1 kg
Domestic shipping weight	≈14 lb	≈ 6.4 kg
Export-packed weight	≈21 lb	≈ 9.5 kg

INCLUDED STANDARD ACCESSORIES

P93C Probe (010-0003-00); black output lead (012-0014-00); red output lead (012-0015-00); 3-conductor power cord (161-0010-03); 3 to 2-wire adapter (103-0013-00); two instruction manuals (070-0231-01).

TYPE 130 DIRECT-READING L-C METER $275

OPTIONAL ACCESSORY



PRODUCTION TEST FIXTURE

Reduces production time required to sort and test capacitors and inductors, order 013-0001-00 . . . . . $7.20

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Signal Sources and Amplifiers Reference

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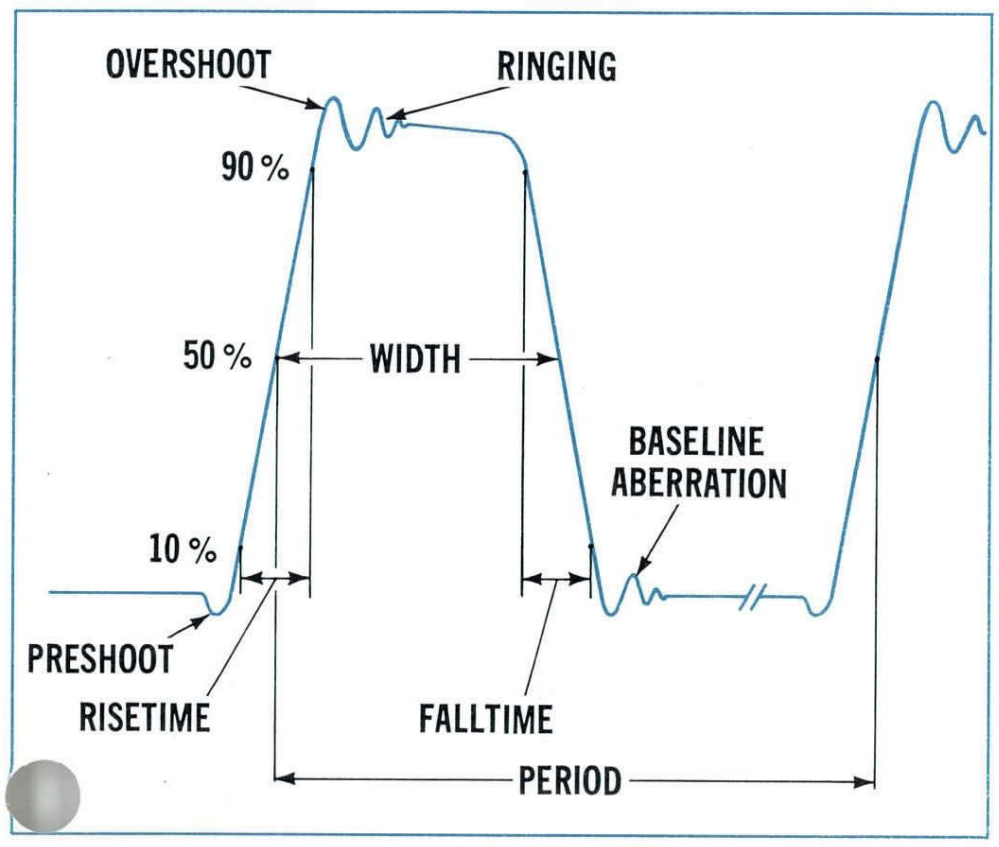
PULSE GENERATORS

The pulse generator is a vital instrument because of the development of circuits and systems operating in the time domain. Switching, pulse, and digital circuits predominate in modern computing, navigation, and data communication systems. The oscilloscope and pulse generator have replaced the voltmeter and oscillator as detector and source.

The pulse generator consists basically of a clock used to generate a train of similiar pulses at time intervals determined by the clock setting; a trigger output synchronous with the clock; a delay circuit which controls the time relation of the pulse out to the trigger; a width-control circuit; an output section which determines pulse waveshape, amplitude, and polarity; and a step attenuator. Auxiliary functions include provisions for external drive, gated operation, and occasionally, a double pulse mode of operation.

Specific applications will require particular characteristics for the energy source being switched. The output impedance, open circuit voltage, and available current must all be known and specified to fit a given pulse generator to a specific application.



GLOSSARY OF TERMS

AMPLITUDE—The full value of the step function, usually specified in voltage but sometimes in current. Amplitude is measured at 50% of pulse width and at 50% of pulse separation.

DELAY TIME—The time period between the trigger output and the pulse output.

DUTY FACTOR—The pulse width divided by pulse period expressed as a percentage. Also known as "duty cycle."

FALLTIME—The period of time required for the trailing edge of the pulse to fall from 90% to 10% of the pulse amplitude. Specified in the same manner as risetime, it is also known as decay time.

OVERSHOOT—In the display of a step function (usually of time), that portion of the waveform which, immediately following the step, exceeds its nominal or final amplitude.

PRESHOOT—In the display of a step function (usually of time), that portion of the waveform which imediately precedes the step. Polarity of the excursion is usually but not necessarily opposite to that of the step which follows.

PULSE JITTER—The variation in time between the leading edges of succeeding pulses.

PULSE PERIOD—The time interval between identical points on adjacent pulses, usually measured from the 50% amplitude point of one leading edge to the 50% amplitude point of the leading edge of an adjacent pulse. Also the reciprocal of the repetition rate.

PULSE WIDTH—The duration of the pulse, usually measured between the half-amplitude points of the leading and trailing edges.

REPETITION RATE—The number of pulses generated per second. Often referred to as frequency, PRF, PRR, or PPS for conciseness in nomenclature.

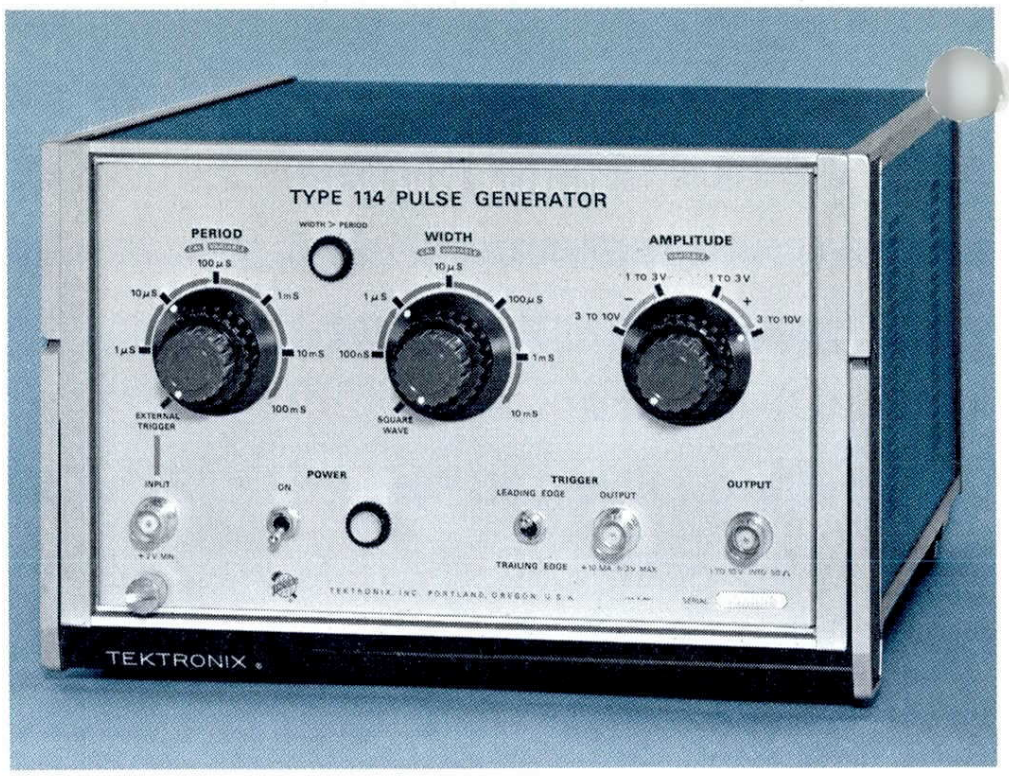
RINGING—A damped oscillatory transient occurring in the output of the system as a result of a sudden change in input.

RISETIME—In the display of a step function, the interval between the time at which the amplitude first reaches specified lower and upper limits. These limits shall be 10% and 90% of the nominal or final amplitude of the step, unless otherwise stated.

10-ns Pulse Generator

114

- ***PULSES OR SYMMETRICAL SQUAREWAVES***
- ***10-ns RISETIME AND FALLTIME***
- ***VARIABLE PULSE PERIOD, WIDTH AND AMPLITUDE***
- ***±10 V INTO 50 OHMS***
- ***SHORT-PROOF OUTPUT***



The Type 114 is a general-purpose pulse and squarewave generator designed for laboratory and production test facilities. The broad operating range of the Type 114 makes it well suited for applications such as studying network response to changes in pulse period and/or width, or determining the step response of systems.

OUTPUT CHARACTERISTICS		
CHARACTERISTIC	PERFORMANCE	ACCURACY
RISE AND FALL TIME	≤10 ns	—
PULSE OR SQUAREWAVE PERIODS	5 ranges from 1 μs to 10 ms continuously variable from 1 μs to 100 ms.	Pulse: ±3% with variable in calibrated position. Squarewave: ±5% from 100 ms to 10 μs, ± 10% at 1 μs with variable in calibrated position
PULSE WIDTH (DURATION)	5 ranges from 100 ns to 1 ms continuously variable from 100 ns to 10 ms	±3%* from 1 μs to 1 ms, ±5%* at 100 ns; variable control in calibrated position
AMPLITUDE	1 V to 3 V and 3 V to 10 V, positive or negative polarity. Variable within each range.	—
POLARITY	Positive or negative	—
ABERRATIONS	≤5% (at maximum amplitude)	—

*Plus 10 ns on negative pulse.

OTHER CHARACTERISTICS

EXTERNAL TRIGGER INPUT REQUIREMENT

Trigger signals ≥ +2 V to +20 V having a risetime of 1 μs or less. Signals up to 2 MHz may be used.

TRIGGER OUTPUT

≥2 V, open circuit; approx 0.5 V into 50-Ω load. Front-panel switch sets trigger output pulse to occur at leading or trailing edge of output pulse.

OPERATING TEMPERATURE

Instrument operating specifications are valid over an ambient temperature range of 0°C to +50°C.

POWER REQUIREMENTS

94.5 V to 137.5 V or 189 V to 275 V, 48 to 440 Hz. Low or high range selected by rear-panel switch. 15-watts maximum power consumption.

DIMENSIONS AND WEIGHTS

Height	6 in	15.3 cm
Width	9 in	22.8 cm
Depth	12⅞ in	33.6 cm
Net weight	9¼ lb	4.2 kg
Domestic shipping weight	≈13 lb	≈ 5.9 kg
Export-packed weight	≈23 lb	≈10.5 kg

INCLUDED STANDARD ACCESSORIES

3 to 2-wire adapter (103-0013-00); two instruction manuals (070-0465-00). (Power Cord for MOD 146B is 161-0031-00).

TYPE 114 PULSE GENERATOR **$340**

TYPE 114 PULSE GENERATOR MOD 146B **$315**

As above, but less cabinet, for mounting in rack adapter.

RACK ADAPTER FOR TYPE 114

Adapts the Type 114 MOD 146B for rackmounting in a 19-inch rack, in only 5¼ inches of panel height. The Type 114 occupies ½-rack width. Two Type 114's can be mounted side-by-side, or alongside other ½-rack width generators, such as the Type 106 Squarewave Generator, 191 Constant-Amplitude Generator, or 115 Pulse Generator. The Type 114 may also be mounted with the ¼-rack width Type 284 Pulse Generator. The Adapter provides forced-air ventilation. Blank panels are available to cover the unused opening when the adapter is not filled. A divider kit is required between instruments, between an instrument and panel, and between panels. Blank panels and divider kits are not included with the Rack Adapter.

RACK ADAPTER (016-0086-01) $135.00

¾-WIDTH BLANK PANEL (016-0133-00) ..... $ 9.00

½-WIDTH BLANK PANEL (016-0081-00) ..... $ 8.00

¼-WIDTH BLANK PANEL (016-0109-00) ..... $ 5.50

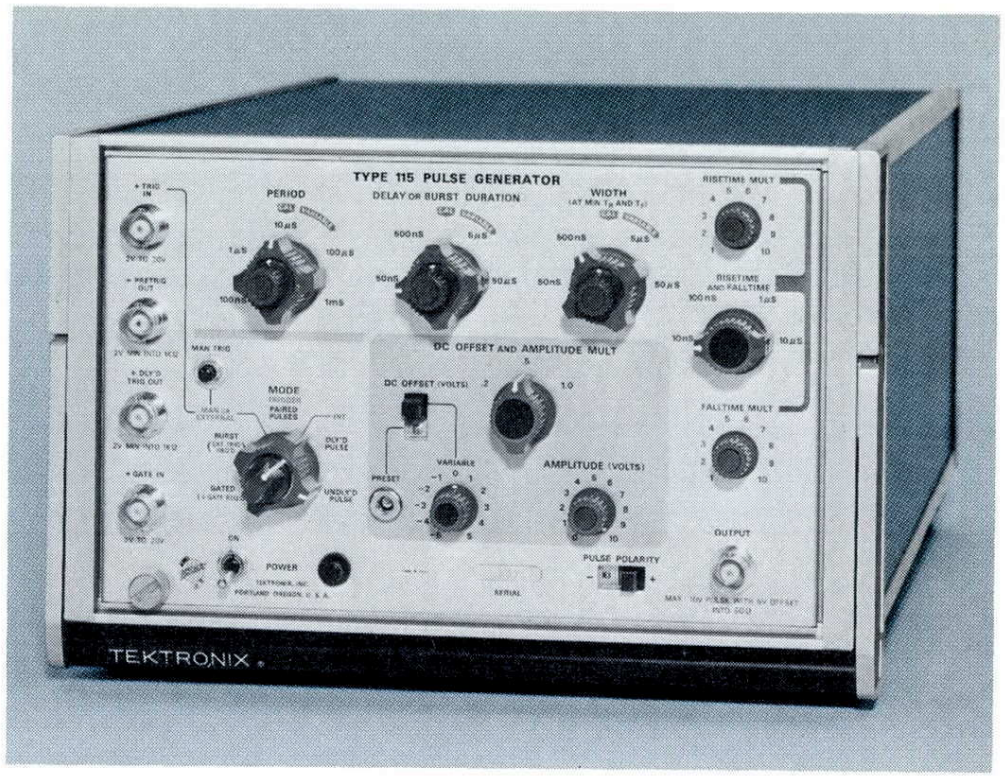
DIVIDER KIT (016-0089-00) ..... $ 11.00

U. S. Sales Prices FOB Beaverton, Oregon

Please refer to Terms and Shipment, General Information Page.

10-ns Pulse Generator with Delay

115



- ***100 Hz-to-10 MHz REPETITION RATE***
- ***VARIABLE DC OFFSET***
- ***VARIABLE RISETIME AND FALLTIME***
- ***PAIRED, BURST, GATED, UNDELAYED AND DELAYED PULSES***
- ***CLEAN PULSES—TOTAL ABERRATIONS ≤3% P-P***
- ***±10 VOLTS INTO 50 Ω***
- ***SHORT-PROOF OUTPUT***

The Type 115 is a 10-MHz, 10-volt, general-purpose pulse generator with separately variable risetime, falltime, width, delay, period, amplitude and baseline offset. It is intended for use in applications where a variety of pulse amplitudes, polarities, shapes and other characteristics are required.

OPERATING MODES

GATED

Provides output pulses for the duration of input gate. First pulse is nearly coincident with input gate and recurs at a repetition rate determined by PERIOD control setting.

BURST

Provides output pulses for the duration of the burst time when initiated by external triggering pulse. Pulse repetition rate determined by PERIOD control. The first pulse in the burst will lag the trigger pulse initiating the burst by an amount dependent upon risetime selected.

PAIRED PULSES

Provides pairs of pulses; one at the time of normal undelayed pulse, and one at the end of delay time. Pairs recur at repetition rate set by PERIOD control.

DELAYED PULSE

Provides pulse at the end of delay time.

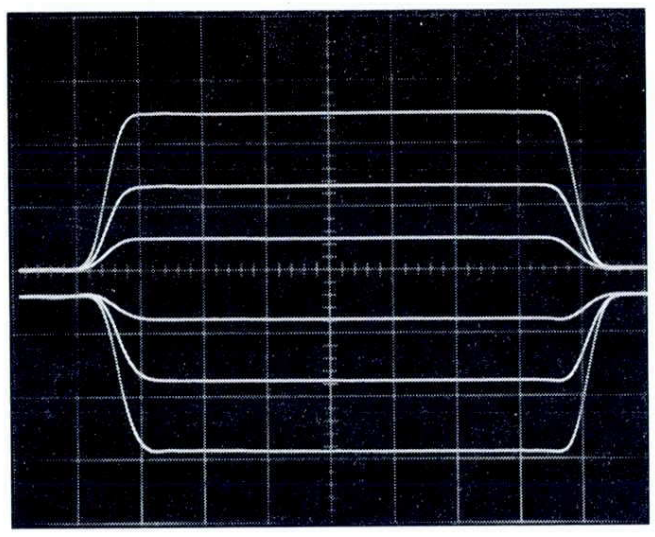
UNDELAYED PULSE

Sequence of pulses with repetition rate set by PERIOD control.

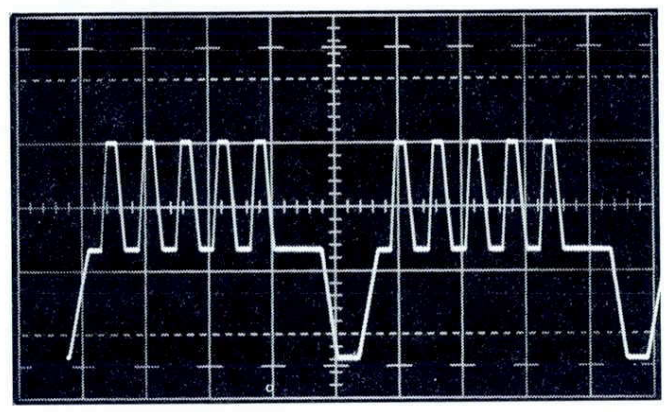
OUTPUT CHARACTERISTICS (TERMINATED IN 50-Ω LOAD)		
CHARACTERISTIC	PERFORMANCE	ACCURACY
RISETIME AND FALLTIME	10 ns to 100 μs in 4 ranges, continuously variable.	Within 5%, ±1 ns, with RISETIME MULT or FALLTIME MULT ccw (position 1).
PERIOD	100 ns to at least 10 ms in 5 ranges, continuously variable. *(MINIMUM PULSE SEPARATION — 50 ns, between the 50% amplitude points of any two adjacent pulses, with risetime and falltimes set to minimum.)*	Within 3% with variable in CAL position (except within 5% on 100-ns range).
DUTY FACTOR	At least 75%, limited by minimum pulse separation.	
WIDTH	50 ns to at least 500 μs in 4 ranges, continuously variable.	Within 3% with variable in CAL position, risetime and falltime set at minimum (except within 5% on the 50-ns range).
DELAY OR BURST TIME	50 ns to at least 500 μs in 4 ranges, continuously variable (refer to pulse separation performance limit above).	Within 3%, ±10 ns with variable in CAL position.
AMPLITUDE	3 ranges, continuously variable. At least ±10 V to less than ±200 mV with MULTIPLIER at X1, ±5 V to ±50 mV with MULTIPLIER at X.5 and ±2 V to ±20 mV with MULTIPLIER at X.2.	The X.5 and X.2 MULTIPLIER positions are referenced to the amplitude of the X1 MULTIPLIER position. They are accurate within 5%.
ABERRATIONS	+3%, −3%, total 3% P-P, or 200 mV times the DC OFFSET AND AMPLITUDE MULTIPLIER settings, whichever is greater.	
DC OFFSET	3 ranges, continuously variable. At least ±5 V with MULTIPLIER at X1, at least ±2.5 V with MULTIPLIER at X.5, and at least ±1 V with MULTIPLIER at X.2.	

10-ns Pulse Generator with Delay

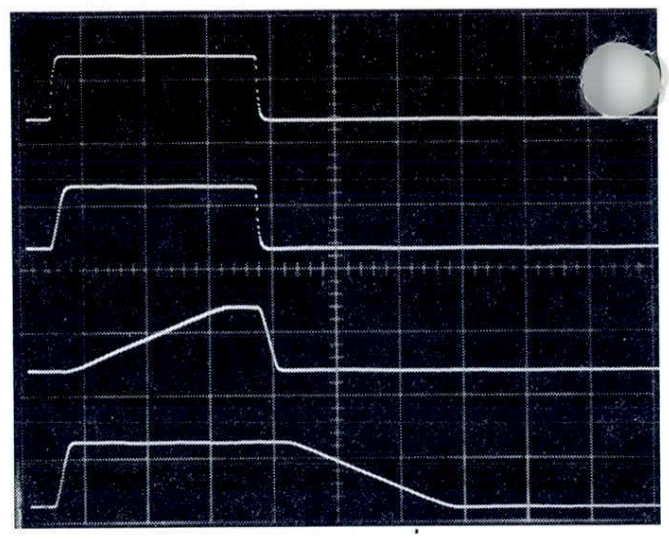
115



Multiple exposure from a fast-risetime oscilloscope showing typical waveform aberrations for positive and negative polarities at various amplitude settings. 20-ns/cm sweep time and 4-V/cm deflection factor.



Single exposure showing combined outputs of two Type 115's. The burst of pulses on top of the positive pedestal was triggered by the + delayed trigger from the instrument generating the pedestal. 10-μs/cm sweep time and 2-V/cm deflection factor.



Multiple exposure showing variable rise-time and falltime. 500-ns/cm sweep time and 10-V/cm deflection factor.

TRIGGERING

A two-position front-panel switch provides selection of internal or external trigger source. A manual pushbutton provides a means to produce a single undelayed pulse, delayed pulse, pulse pair or burst of pulses.

INPUTS

+ TRIGGER

	PULSE	SINEWAVE
FREQUENCY	At least 0.5-V/μs rate of rise	1 kHz to 10 MHz
MINIMUM AMPLITUDE	+2 V	2-V peak
MAXIMUM AMPLITUDE	+20 V, decreasing to +4 V at 10 MHz	20-V peak, decreasing to 4-V peak at 10 MHz

+ GATE

Accepts gate from +2 V to +20 V.

AUXILIARY OUTPUTS

+ PRETRIGGER

At least 2 V into 1 kΩ.

+ DELAYED TRIGGER

At least +2 V into 1 kΩ.

OTHER CHARACTERISTICS

OPERATING TEMPERATURE

Instrument operating specifications are valid over an ambient temperature range of +20° C to +30° C.

POWER REQUIREMENTS

90 to 136 VAC or 180 to 272 VAC, 48 to 66 Hz, 115 watts at 115 VAC, 60 Hz. Rear panel selector provides rapid accommodation for six line-voltage ranges.

DIMENSIONS AND WEIGHTS

Height	6 in	15.3 cm
Width	9 in	22.8 cm
Depth	15⅞ in	42.0 cm
Net weight	15 lb	6.8 cm
Domestic shipping weight	≈22 lb	≈ 9.9 kg
Export-packed weight	≈33 lb	≈14.9 kg

INCLUDED STANDARD ACCESSORIES

50-Ω, 5-W termination (011-0099-00); 50-Ω BNC cable (012-0057-01); 3 to 2-wire adapter (103-0013-00); two instruction manuals (070-0786-00).

TYPE 115 PULSE GENERATOR . . . . . **$[illegible]**

TYPE 115 PULSE GENERATOR MOD 146B (without cabinet) **$840**

Same accessories as above with addition of a detachable power cord (161-0031-00).

OPTIONAL ACCESSORIES

RACK ADAPTER FOR TYPE 115

Adapts the Type 115 MOD 146B for rackmounting in a 19-inch rack, in only 5¼ inches of panel height. The Type 115 occupies ½-rack width. Two Type 115's can be mounted side-by-side, or alongside other ½-rack width generators, such as the Type 106 Squarewave Generator, 114 Pulse Generator, or 191 Constant-Amplitude Generator. The Type 115 may also be mounted with the ¼-rack width Type 284 Pulse Generator. The Adapter provides forced-air ventilation. Blank panels are available to cover the unused opening when the adapter is not filled. A divider kit is required between instruments, between an instrument and panel, and between panels. Blank panels and divider kits are not included with the Rack Adapter.

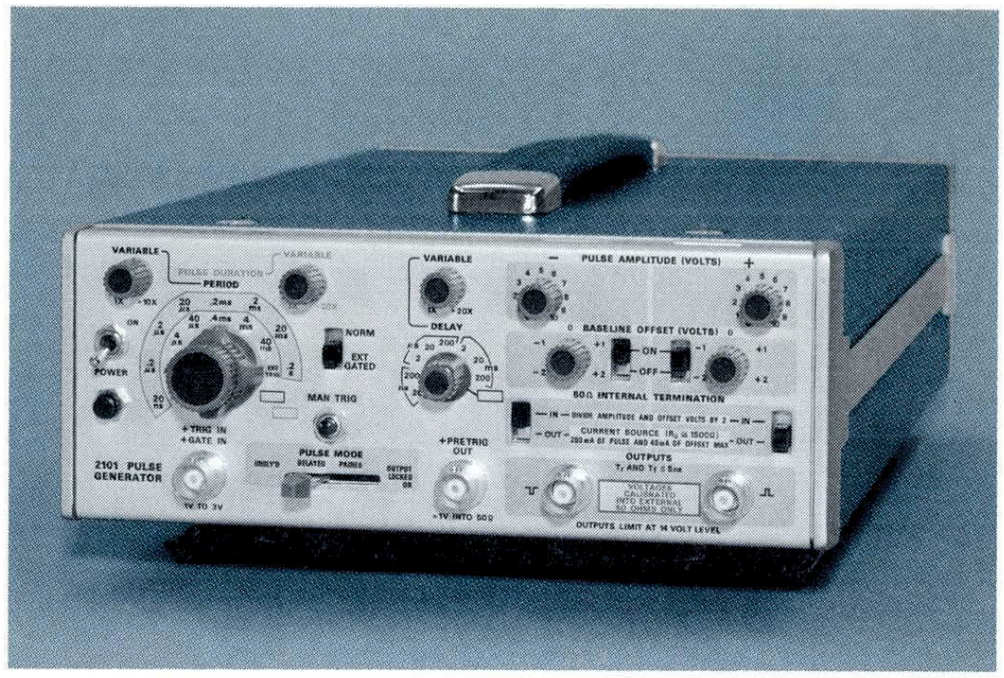
RACK ADAPTER (016-0086-01)	$135.00
¾-WIDTH BLANK PANEL (016-0133-00)	$ 9.00
½-WIDTH BLANK PANEL (016-0081-00)	$ 8.00
¼-WIDTH BLANK PANEL (016-0109-00)	$ 5.50
DIVIDER KIT (016-0089-00)	$ 11.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

NEW

2101 5-ns Pulse Generator 2101

- *2.5 Hz-to-25 MHz REPETITION RATE*
- *VARIABLE BASELINE OFFSET*
- *5-ns RISETIME AND FALLTIME*
- *PAIRED, UNDELAYED, DELAYED, AND OUTPUT LOCKED ON MODES*
- *EXTERNAL GATE INPUT*
- *SIMULTANEOUS POSITIVE- AND NEGATIVE-GOING PULSES—10 VOLTS INTO 50 Ω*
- *SHORT-PROOF OUTPUTS*



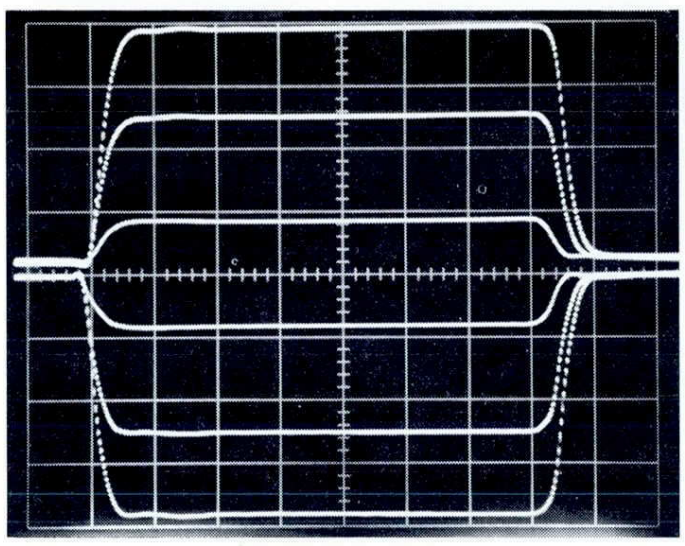
The Type 2101 is a compact, 25 MHz, 10-volt, general-purpose pulse generator with simultaneous positive- and negative-going pulse outputs. Switch positions are provided for selection of a specific pulse period, duration, and delay, within the calibrated range of the respective control. These positions can also be used to reduce the repetition rate, and to increase the duration and delay. The only limiting factor is the physical size of the user-supplied timing capacitors.

An external gate input permits output pulses for the duration of the gate signal. Useful for all pulse modes, except OUTPUT LOCKED ON mode. Independent baseline offset controls are provided for the positive-going and negative-going pulse outputs.

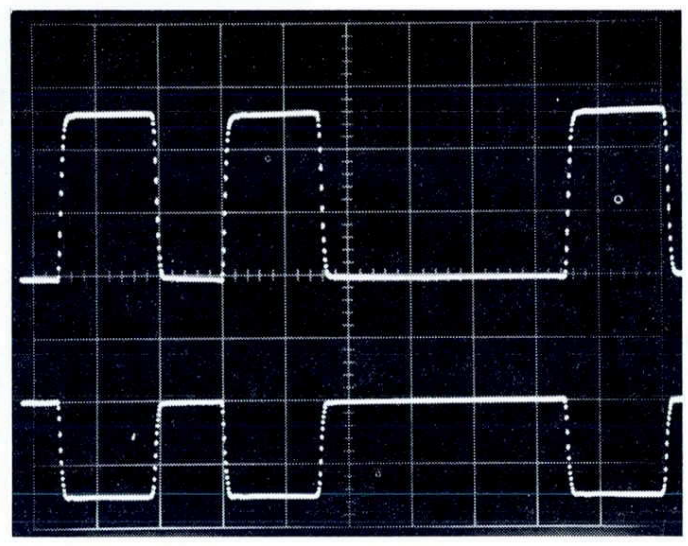
OUTPUT CHARACTERISTICS (TERMINATED IN 50-Ω LOAD)		
CHARACTERISTIC	PERFORMANCE	ACCURACY
RISETIME AND FALLTIME	5 ns or less	
PERIOD	40 ns to 400 ms in 7 ranges, continuously variable (MINIMUM PULSE SEPARATION—20 ns or 20% of DURATION, whichever is greater, between the 50% amplitude points of any two adjacent pulses).	Within 3% and 2 ns of indicated PERIOD with VARIABLE in 1X position.
DUTY FACTOR	At least 80% except when period is ≤100 ns. Decreases from 80% at 100 ns period to 50% at 40 ns period. Minimum off time is 20 ns.	
DURATION	20 ns to 400 ms (to 4 s with external trigger) in 7 ranges, continuously variable.	Within 3% and 2 ns of PULSE DURATION with VARIABLE in 1X position.
DELAY	20 ns to 4 s in 8 ranges, continuously variable (refer to pulse separation performance limit above).	Within 3% and 2 ns of indicated DELAY with VARIABLE in 1X position.
AMPLITUDE	With 50-Ω Internal Termination Out— 0.5 V or less to 10 V, continuously variable. Current output is 10 mA or less to 200 mA, continuously variable. With 50-Ω Internal Termination In—0.25 V or less to 5 V.	Within +5% −2% Within ±10%
BASELINE OFFSET	With 50-Ω Internal Termination Out— At least + and −2 V, + and −40 mA, continuously variable around zero. With 50-Ω Internal Termination In— At least + and −1 V, continuously variable around zero.	Control calibrated for external load impedance of 50 ohms.
ABERRATIONS	LEADING EDGE: preshoot ≤3% or 100 mV, whichever is greater (time interval is 5 ns prior to 10% amplitude); overshoot and ringing +3%, −3%, total not to exceed 3% or 100 mV, whichever is greater (time interval is 5 ns after 90% amplitude). PULSE TOP FLATNESS is ≤3% (time interval is 5 ns after 90% amplitude to 5 ns prior to trailing edge 90% amplitude). TRAILING EDGE: preshoot ≤3% or 30 mV, whichever is greater (time interval is 5 ns prior to 90% amplitude); overshoot and ringing +3%, −3%, total not to exceed 3% or 100 mV, whichever is greater (time interval is 5 ns after 10% amplitude). BASELINE FLATNESS is ≤3% (time interval is 5 ns after 10% amplitude to 5 ns prior to leading edge 10% amplitude).	

NEW

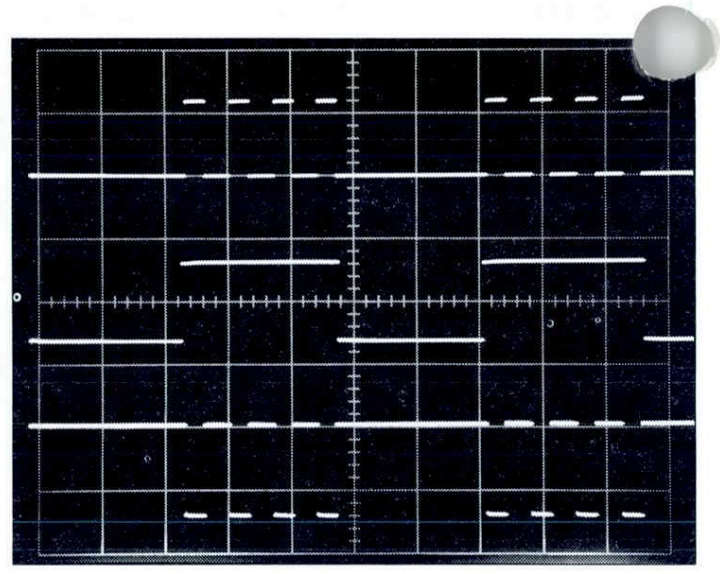
2101 5-ns Pulse Generator 2101



Multiple exposure from a fast-risetime oscilloscope showing typical waveform aberrations for positive and negative polarities at various amplitude settings. 10-ns/div sweep time and 2-V/div deflection factor.



Single exposure showing simultaneous positive- and negative-going paired pulse outputs. 50-ns/div sweep time and 2-V/div deflection factor.



Type 2101 in the external gated mode. Single exposure top to bottom. Gated positive-going pulses, gating signal, negative-going pulses. 20-μs/div sweep time and 1-V/div deflection factor.

OPERATING MODES

UNDELAYED
Sequence of pulses with repetition rate set by PERIOD control.

DELAYED
Pulse output is delayed for a time interval determined by DELAY controls. Delay time is the time between leading edges of an undelayed pulse and the delayed pulse.

PAIRED
Provides pairs of pulses, one at the time normal undelayed pulse and one at the end of delay time. Pairs recur at repetition rate set by PERIOD control.

OUTPUT LOCKED ON
A DC output is provided which is locked to a level determined by PULSE AMPLITUDE and OFFSET controls.

TRIGGERING

PERIOD switch provides selection of internal or external trigger source. A manual push button provides a means to produce one pulse generation cycle when the PERIOD switch is set for EXT TRIG.

INPUTS

+ TRIGGER
+1 V to +3 V, to a maximum frequency of 25 MHz.

+ GATE
+1 V to +3 V, to a maximum frequency of 25 MHz.

OTHER CHARACTERISTICS

+ PRETRIGGER OUT
At least 1 V into 50 Ω.

SOURCE RESISTANCE
50 Ω within 5% with the internal termination switched in, at least 1500 Ω when in current source function with internal termination switched out.

OPERATING TEMPERATURE
Instrument operating specifications are valid over an ambient temperature range of 0°C to +50°C.

POWER REQUIREMENTS
90 to 136 VAC or 180 to 272 VAC, 48 to 440 Hz; 55 watts maximum at 115 VAC and 60 Hz. A rear-panel selector provides accommodation for 6 line voltage ranges.

DIMENSIONS AND WEIGHTS

Height	3⅞ in	9.7 cm
Width	8 in	20.3 cm
Depth	14¾ in	37.5 cm
Net Weight	8¾ lb	4 kg

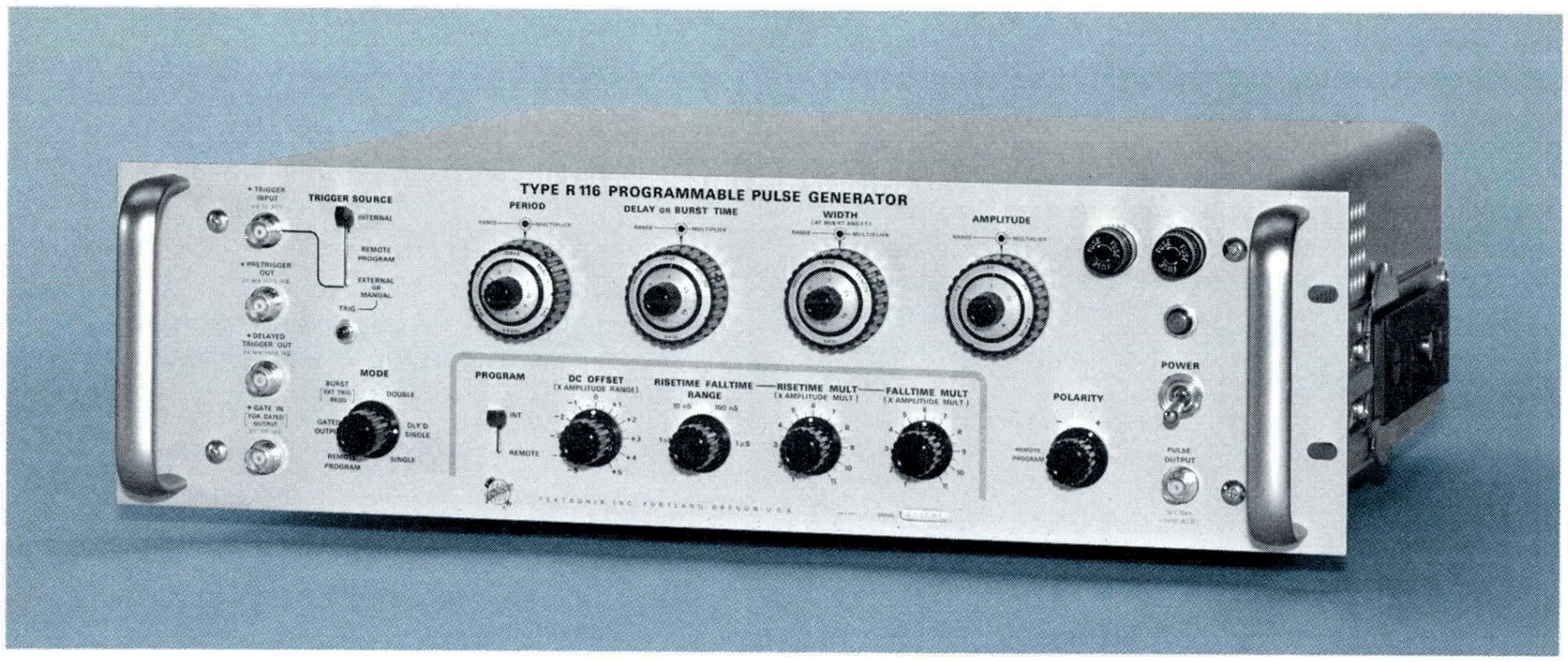
INCLUDED STANDARD ACCESSORIES
Two 50-Ω, 5-W terminations (011-0049-01); two 50-Ω BNC cables (012-0117-00); two instruction manuals (070-1029-00).

TYPE 2101 PULSE GENERATOR $700

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Programmable Pulse Generator

R116



CALIBRATED AND PROGRAMMABLE PARAMETERS

- ***MODE***
- ***TRIGGER SOURCE***
- ***PERIOD***
- ***DELAY OR BURST TIME***
- ***WIDTH***
- ***POLARITY***
- ***AMPLITUDE***
- ***DC OFFSET***
- ***RISETIME AND FALLTIME***

The Type R116 is a broad-range, programmable pulse generator intended primarily for applications where various combinations of pulse amplitude, width, polarity, and other features are required in rapid sequence.

All functions and parameters are easily programmable with no need for extra-cost modifications. The Type R116 can also be operated manually from calibrated front-panel controls for initial test setup and for applications not requiring external programming. Full programming capability requires 21 bits and 7 analog lines.

PULSE CHARACTERISTICS (at 10-volts amplitude)

CHARACTERISTICS	RANGE	BASIC ACCURACY (% of dial)	REQUIRED PER PROGRAM
*RISETIME AND FALLTIME	10 ns to 110 μs	±5% (except ± 10% on 1 and 10 ns range. <10 ns uncalibrated.)	3 bits + 2 resistors
*PERIOD	100 ns to 11 ms	±3%, except shortest period range is ±5%	4 bits + 1 resistor
*WIDTH	50 ns to 550 μs	±3%, except shortest width is ±5%.	3 bits + 1 resistor
*DELAY OR BURST TIME	50 ns to 550 μs	±3% +10 ns	3 bits + 1 resistor
*AMPLITUDE (into 50 Ω)	0.4 to 2 V 1 to 5 V 2 to 10 V	±3% ±10 mV ±3% ±25 mV ±3% ±50 mV	2 bits + 1 resistor
*DC OFFSET (continuous)	−5 V to +5 V	±5% ±200 mV	1 resistor
POLARITY	positive or negative		1 bit
DUTY FACTOR	At least 75%, limited by a minimum pulse separation of 100 ns between the 50% amplitude points of any two adjacent pulses with the rise and falltimes set to minimum.		

*These parameters are calibrated and continuously variable.

Programmable Pulse Generator

R116

PROGRAM ACCURACY

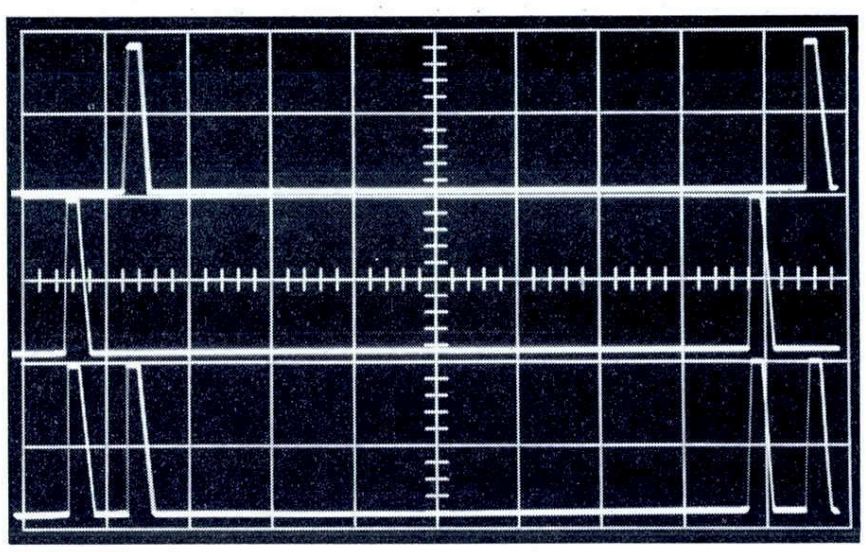
Accuracy of the remote program when using recommended program resistor values is the same as the corresponding front-panel control plus 2%, plus any error in the value of the program resistor. For example, the period which has a basic accuracy of ±3% from the front panel would have a maximum error of ±5%, plus the error in the programming resistor when it is remotely programmed. Accuracy of remote programming may be improved by calibrating the instrument for remote programming rather than for front-panel operation.

OPERATING MODES

SINGLE
Undelayed pulses.

DELAYED SINGLE
Pulses occurring at the end of the delay time.

DOUBLE
Pairs of pulses: one occurring at the time of the normal undelayed pulse, one occurring at the end of the delay time. 100-ns minimum pulse separation.



Multiple exposure showing timing relationships between Single, Delayed Single, and Double operating modes. Oscilloscope triggered from Type R116 Pretrigger. 50-μs/cm sweep time, 5-V/cm deflection factor.

BURST
Output pulses obtained for the duration of Burst Time when initiated by external triggering pulse. Pulses occur at internal repetition rate.

GATED OUTPUT
Output pulses obtained for the duration of input gate. Pulses are synchronous with input gate and occur at internal repetition rate.

REMOTE PROGRAM
Permits remote programming of the operating mode. Programming requires 4 bits.

INPUTS

+TRIGGER
Accepts pulses with 0.5-V/μs rate of rise or sinewaves from 1 kHz to 10 MHz. Pulse amplitude may be +2 V to +20 V, decreasing to a maximum of +4 V at 10 MHz. Sinewave amplitude may be 2 to 20 V peak to peak, 1 kHz to 5 MHz, 3 to 4 V peak to peak at 10 MHz.

+GATE
Accepts gate from +2 V to +10 V. Output pulses start approximately 100 ns after gate reaches +2-V level and continue until gate drops to 0 V. Output pulses synchronous with gate. DC-coupled input.

AUXILIARY OUTPUTS

+PRETRIGGER
2 V minimum into 1 kΩ.

+DELAYED TRIGGER
2 V minimum into 1 kΩ.

OTHER CHARACTERISTICS

OPERATING TEMPERATURE
Instrument operating specifications are valid over an ambient temperature range of +20°C to +30°C.

POWER REQUIREMENTS
94.5 to 137.5 V or 189 to 275 V, selectable by rear-panel switch. 48 to 66 Hz, 100 watts maximum.

DIMENSIONS AND WEIGHTS

Height	5¼ in	13.3
Width	19 in	48.3 cm
Depth	17½ in	44.5 cm
Net weight	25¾ lb	11.7 kg
Domestic shipping weight	≈61 lb	≈27.7 kg
Export-packed weight	≈86 lb	≈39.1 kg

INCLUDED STANDARD ACCESSORIES
30-in 50-Ω BNC cable (012-0057-01); 50-Ω BNC termination (011-0099-00); 36-pin remote program connector (131-0293-00); set mounting tracks (351-0084-00); set mounting hardware, cabinet feet kit (016-0052-00); 3-conductor power cord (161-0024-03); 3 to 2-wire adapter (103-0013-00); two instruction manuals (070-0498-00).

TYPE R116 PULSE GENERATOR $1825

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience. See catalog accessory pages for additional information.

CIRCUIT BOARD EXTENSION
Permits mounting of circuit boards away from surrounding circuitry for convenient servicing.
Order 012-0078-00 ..... $19

U. S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information Page.

250-ps Pulse Generator

109

- ***250-ps RISETIME PULSES***
- ***ALTERNATE PULSES OF EQUAL OR DIFFERENT TIME DURATION***
- ***0-55 V CALIBRATED VARIABLE AMPLITUDE***
- ***SELECTABLE POLARITY***

The Type 109 is intended for use with fast-rise sampling or conventional oscilloscopes that generate their own internal sweep trigger. The Type 109 is transistorized and requires no warmup time before operating.

PULSE CHARACTERISTICS	
CHARACTERISTICS	PERFORMANCE
RISETIME	Less than 250 ps
AMPLITUDE	Adjustable from 0 through 55 V, accuracy ±3%
REPETITION RATE	Preset between 550 p/s and 720 p/s (using two charge lines)
PULSE DURATION	0.5 ns to max of 100 ns at full rep rate; 300 ns at half rep rate
DECAY	approx 10% in 300 ns
POLARITY	Positive or negative
OUTPUT IMPEDANCE	50 Ω

CHARGE LINES

Either one or two charge lines can be used to provide alternate equal or unequal pulses as desired. Equal charge lines produce a repetition rate of 550 pulses per second to 720 pulses per second.

EXTERNAL DC CHARGE VOLTAGE INPUTS

Use of external charge voltages allows alternate pulses to be of different amplitude and polarity. Maximum external charge voltage is 600 volts. With up to 100-volts input, the output amplitude will be half the external input amplitude. At voltage inputs over 100 volts, the output amplitude will be less than half the input amplitude. At pulse outputs over 50 volts, irregularities may occur.

POWER REQUIREMENT

Wired for 105 to 125 V, may be ordered with the taps connected for 210 to 250 V. 50 to 800 Hz, 60 watts maximum.

DIMENSIONS AND WEIGHTS

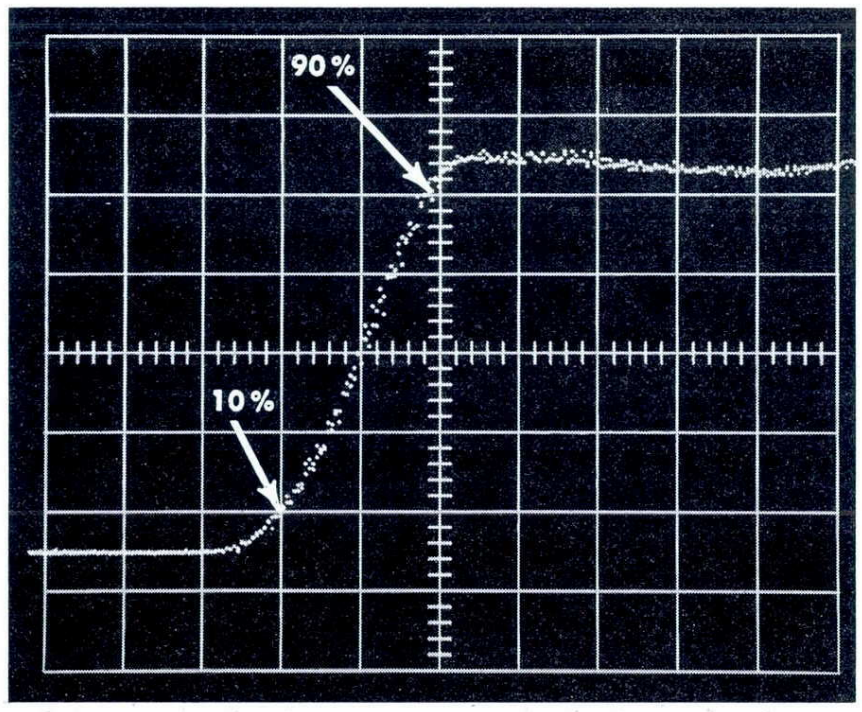
Height	7¾ in	19.7 cm
Width	4⅞ in	12.2 cm
Length	11⅞ in	30.2 cm
Net weight	8¼ lb	3.8 kg
Domestic shipping weight	≈17 lb	≈ 7.7 kg
Export-packed weight	≈28 lb	≈12.7 kg

INCLUDED STANDARD ACCESSORIES

Charge network (017-0067-00); three 5-ns 50-Ω RG213 cables (017-0502-00); 3-conductor power cord (161-0010-03); 3 to 2-wire adapter (103-0013-00); two instruction manuals (070-0299-00).

TYPE 109 PULSE GENERATOR $420

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.



Waveform showing the Type 109 pulse displayed on a Tektronix Type 564B Oscilloscope with 3S2/S1, and 3T2 Sampling Plug-In Units. The equivalent sweep rate is 200 ps/div. Combined risetime of the system, between 10% and 90% amplitude levels, is less than 400 ps.

Pretrigger Pulse Generator

111

- ***0.5-ns RISETIME PULSES***
- ***PULSE DURATIONS to 1.5 μs***
- ***10 Hz-to-100 kHz REPETITION RATE***
- ***SELECTABLE POLARITY***
- ***30 to 250-ns PRETRIGGERING***

The Type 111 is a low cost, fast-rise pulse generator. The unit provides two pulse outputs: fast-rising output pulses and pretrigger pulses. The pretrigger pulses occur from 30 to 250 nanoseconds ahead of each output pulse. Pretrigger pulses can be used as a regenerated trigger signal for sampling systems without internal delay lines or as a triggering signal for a conventional oscilloscope. The amount of delay between the pretrigger pulse and the output pulse can be varied by means of a front-panel control. This eliminates the need for delay cables.

OUTPUT PULSE CHARACTERISTICS	
CHARACTERISTIC	**PERFORMANCE (into 50 Ω)**
RISETIME	≤0.5 ns (either polarity)
REPETITION RATE	Continuously variable, 10 Hz to 100 kHz
PULSE DURATION	2 ns to 1.5 μs with appropriate charge line
AMPLITUDE	≥10 V
POLARITY	Positive or negative
OUTPUT IMPEDANCE	50 Ω
ABERRATIONS	≤5% P to P on leading edge and top of output pulse; ≤10% P to P on region following the pulse

PRETRIGGER PULSE CHARACTERISTICS

Amplitude: ≈10 V, duration: ≈300 ns, risetime: ≤7 ns.

PULSE DELAY

30 to 250 ns, continuously variable. Time jitter less than 100 ps.

OUTPUT IMPEDANCE

50 ohms.

EXTERNAL TRIGGER SIGNAL

+3 V or greater at a rate of rise of 3 V/μs or faster. As long as rate of rise is maintained, repetition rates from 0 to 100 kHz can be used.

POWER REQUIREMENTS

Wired for 105 to 125 V, may be ordered with taps connected for 210 to 250 V. 50 to 800 Hz, approx 35 watts.

DIMENSIONS AND WEIGHTS

Height	$11\frac{7}{16}$ in	29 cm
Width	$6\frac{15}{16}$ in	17.7 cm
Depth	$11\frac{5}{16}$ in	28.7 cm
Net weight	9 lb	4.1 kg
Domestic shipping weight	≈14 lb	≈ 6.4 kg
Export-packed weight	≈20 lb	≈ 9.1 kg

INCLUDED STANDARD ACCESSORIES

5-ns 50-Ω RG213 cable (017-0502-00); 9-ns 50-Ω charge line (017-0506-00); 50-Ω 10X GR attenuator (017-0078-00); 3-conductor power cord (161-0010-03); 3 to 2-wire adapter (103-0013-00); two instruction manuals (070-0252-00).

TYPE 111 PULSE GENERATOR $435

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Pulse Generator

284

- ***PULSE OUTPUT WITH ≤70-ps RISETIME***
- ***SINEWAVE AND SQUAREWAVE OUTPUTS***
- ***COMPACT, SOLID-STATE DESIGN***

The Type 284 Pulse Generator provides the facility for verifying the performance of Sampling Oscilloscopes. This generator offers, in one small instrument, all of the signals required to check the risetime, vertical deflection factors, and horizontal sweep rates. A pre-trigger output is also provided.

In addition to checking the transient response of sampling oscilloscopes, the fast-rise step of the pulse output is an excellent 50 Ω signal source for TDR measurements. The Type 284 is available in a cabinet version, or modified for rackmounting in standard 19-inch rack using the optional Rack Adapter.

OUTPUT CHARACTERISTICS

PULSE OUTPUT

70 ps or less risetime with a pulse width of 1 μs and a repetition rate of 50 kHz. Aberrations immediately following positive-going transitions are less than ±3%, 3% total peak-to-peak; after 2 ns, less than ±2%, 2% total peak-to-peak. Pulse amplitude is approx +200 mV into 50 ohms. Source impedance is 50 ohms.

SQUAREWAVE OUTPUT

Periods of 10 μs, 1 μs or 100 ns. Output amplitude is 10 mV, 100 mV or 1 V into 50 ohms.

SINEWAVE OUTPUT

Periods of 10 ns or 1 ns. Output amplitude is 100 mV into 50 ohms.

TRIGGER OUTPUT

Squarewave, sinewave, or pulse output, depending on the selected main pulse output. Amplitude is 200 mV, accurate within 40%. When PULSE OUTPUT is selected, the trigger can be switched to arrive 5 ns ±5 ns or 75 ns ±5 ns ahead of the main pulse. Risetime is 3 ns or less; pulse width is 10 ns or greater.

TIMING AND AMPLITUDE ACCURACY

OUTPUT	PERIOD	TIMING ACCURACY	AMPLITUDE ACCURACY		
			1 V	100 mV	10 mV
Pulse	20 μs	±10%			
Square-wave	10 μs	±0.5%	±0.5%	±1%	±1.5%
	1 μs				
	100 ns	±0.05%*	±2%†	±2.5%†	±3%†
Sine-wave	10 ns	±1%		±20%	
	1 ns				

* crystal controlled

† 20 ns after transition

OTHER CHARACTERISTICS

OPERATING TEMPERATURE

Instrument operating specifications are valid over an ambient temperature range of 0°C to +50°C.

POWER REQUIREMENTS

6.5 watts, 48 Hz to 440 Hz. Quick-change line-voltage selector permits operation from 90 V to 136 V or 180 V to 272 V.

DIMENSIONS AND WEIGHTS

Height	6¾ in	17.2 cm
Width	4½ in	11.4 cm
Depth	15 in	38.1 cm
Net weight	8½ lb	3.8 kg
Domestic shipping weight	≈15½ lb	≈7.1 kg
Export-packed weight	≈20 lb	≈9.1 kg

INCLUDED STANDARD ACCESSORIES

50 Ω BNC coaxial cable (012-0057-01); right angle 3-conductor power cord (161-0024-03); 3 to 2-wire adapter (103-0013-00); two instruction manuals (070-0754-00).

TYPE 284 PULSE GENERATOR **$555**

TYPE 284 PULSE GENERATOR MOD 146B (without cabinet) **$530**

Same accessories as above with addition of a detachable power cord (161-0031-00).

RACK ADAPTER FOR TYPE 284

Adapts the Type 284 MOD 146B for rackmounting in a 19-inch rack, in only 5¼ inches of panel height. The Type 284 occupies ¼-rack width. Up to four Type 284's can be mounted side-by-side, or two Type 284's can be mounted alongside one ½-rack width generator, such as the Type 106 Squarewave Generator, 114 Pulse Generator, Type 115 Pulse Generator, or 191 Constant-Amplitude Generator. The Adapter provides forced-air ventilation. Blank panels are available to cover the unused opening when the adapter is not filled. A divider kit is required between instruments, between an instrument and panel, and between panels. Blank panels and divider kits are not included with the Rack Adapter.

RACK ADAPTER (016-0086-01) $135.00

¾-WIDTH BLANK PANEL (016-0133-00) ..... $ 9.00

½-WIDTH BLANK PANEL (016-0081-00) ..... $ 8.00

¼-WIDTH BLANK PANEL (016-0109-00) ..... $ 5.50

DIVIDER KIT (016-0089-00) ..... $ 11.00

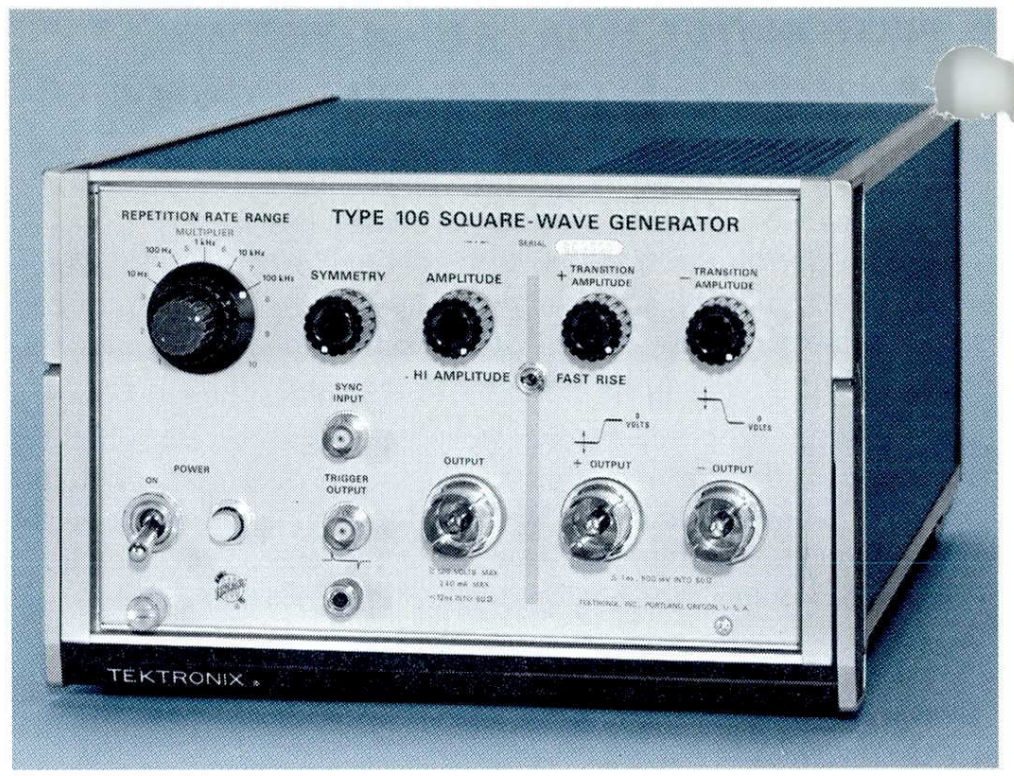
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Squarewave Generator

106

- ***1-ns RISETIME***
- ***10 Hz-to-1 MHz REPETITION RATE***
- ***HI-AMPLITUDE OR FAST-RISE OUTPUTS***
- ***SYNC INPUT, TRIGGER OUTPUT***

This general-purpose generator provides simultaneous positive and negative-going output transitions with ≤1-ns risetime into 50 Ω, or positive-going hi-amplitude output with ≤12-ns risetime into 50 Ω. A clean transition and flat top make the Type 106 ideal for checking oscilloscope transient response. It can be used in such applications as diode recovery, core testing, digital and analog design.



OUTPUT CHARACTERISTICS		
CHARACTERISTIC	+ and — FAST-RISE OUTPUTS	HI-AMPLITUDE OUTPUT
RISETIME (into 50 Ω)	≤1 ns at 0.5 V	≤12 ns at 12 V, ≤20 ns at 0.5 V ≤120 ns with no external load
REPETITION RATE	Continuously variable from 10 Hz to at least 1 MHz	
SYMMETRY	Duty cycle variable from ≤45% to ≥55%	
AMPLITUDE (into 50 Ω)	≤50 mV to ≥500 mV	≤0.5 V to ≥12 V, (≤7 V to ≥120 V unterminated)
ABERRATIONS (into 50 Ω)	≤ + and — 2% or + and — 6 mV (whichever is greater) in first 5 ns*, typically ≤0.5% for remainder of pulse top	≤ + and — 2% in first 100 ns*, typically ≤ 0.5% for remainder of pulse top

*Time period begins at 98%-amplitude point on rising edge.

OTHER CHARACTERISTICS

SYNC INPUT

Accepts sinewaves, squarewaves, or pulses. Accepts 5 V-to-100 V peak-to-peak sinewave, 2.5 V-to-50 V pulse or squarewave, 100 Hz to 1 MHz.

TRIGGER OUTPUT

Positive and negative going triggers occur within 50 ns of the rise and fall of the HI-AMPLITUDE squarewave. Positive triggers occur within 50 ns of leading edge of fast-rise outputs. Risetime is 50 ns and amplitude is 0.1 V or more into 50 Ω. Time jitter is less than 300 ps.

OPERATING TEMPERATURE

Instrument operating specifications are valid over an ambient temperature range of 0°C to +50°C.

POWER REQUIREMENTS

103.5 V to 126.5 V or 207 V to 253 V, 50 to 60 Hz. Low or high range selected by rear-panel switch. Approx 85-watts maximum power consumption at 115 VAC.

DIMENSIONS AND WEIGHTS

Height	6 in	15.2 cm
Width	9 in	22.8 cm
Depth	14¾ in	40 cm
Net weight	15 lb	6.8 kg
Domestic shipping weight	≈21 lb	≈ 9.6 kg
Export-packed weight	≈29 lb	≈13.2 kg

INCLUDED STANDARD ACCESSORIES

5-ns 50-Ω RG213 cable (017-0502-00); GR-to-BNC 50-Ω thru-line termination (017-0083-00); 3 to 2-wire adapter (103-0013-00); two instruction manuals (070-0523-00). (Power cord for MOD 146B is 161-0031-00).

TYPE 106 SQUAREWAVE GENERATOR $665

TYPE 106 SQUAREWAVE GENERATOR MOD 146B . $640

As above, but less cabinet, for mounting in Rack Adapter.

RACK ADAPTER FOR TYPE 106

Adapts the Type 106 MOD 146B for rackmounting in a 19-inch rack, in only 5¼ inches of panel height. The Type 106 occupies ½-rack width. Two Type 106's can be mounted side-by-side, or alongside other ½-rack width generators, such as the Type 191 Constant-Amplitude Generator, 114 Pulse Generator, or 115 Pulse Generator. The Type 106 may also be mounted with the ¼-rack width Type 284 Pulse Generator. The Adapter provides forced-air ventilation. Blank panels are available to cover the unused opening when the adapter is not filled. A divider kit is required between instruments, between an instrument and panel, and between panels. Blank panels and divider kits are not included with the Rack Adapter.

RACK ADAPTER (016-0086-01)	$135.00
¾-WIDTH BLANK PANEL (016-0133-00)	$ 9.00
½-WIDTH BLANK PANEL (016-0081-00)	$ 8.00
¼-WIDTH BLANK PANEL (016-0109-00)	$ 5.50
DIVIDER KIT (016-0089-00)	$ 11.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Constant-Amplitude Signal Generator

191

- ***350-kHz to 100-MHz SINEWAVES***
- ***5-mV to 5.5-V CONSTANT AMPLITUDE***
- ***50-kHz AMPLITUDE REFERENCE***

The Type 191 is a variable-frequency sinewave generator with a constant-amplitude output over the entire frequency range. Both output amplitude and frequency are calibrated. Amplitude is held constant during frequency variations by continuous sampling of peak-to-peak voltage.

OUTPUT CHARACTERISTICS

FREQUENCY RANGE

Continuously variable and calibrated in 7 ranges from 350 kHz to 100 MHz, plus 50-kHz reference output. Accuracy within ±2% of selected frequency with output terminated in 50 Ω or unterminated (except ±5% on 0.5-5 V range with output unterminated).

AMPLITUDE RANGE

5 mV to 5 V peak to peak in 3 ranges (10 calibrated steps per range) into 50 Ω termination. Unterminated output is 2X indicated output. Amplitude is continuously variable (uncalibrated) between steps and to 10% over the top of each range (5.5 V terminated or 11 V unterminated).

AMPLITUDE ACCURACY

50-kHz reference output accurate within ±3% of indicated amplitude on 0.5-5 V range, ±4% on 50-500 mV range, and ±5% on 5-50 mV range, into ±1% 50 Ω termination. Accuracy improved with a more accurate termination. Unterminated output is 2X indicated amplitude, at same accuracy. When the frequency is varied from 350 kHz to 100 MHz, the output amplitude into 50 Ω (at the output connector or through no more than 5 ns of RG8 cable) will not vary more than ±3% from actual amplitude at 50 kHz, except when using the 5-mV to 50-mV range the output may vary +3%-5% on frequencies from 42 MHz to 100 MHz.

HARMONIC CONTENT

Typically less than 5%.

OTHER CHARACTERISTICS

OPERATING TEMPERATURE

Instrument operating specifications are valid over an ambient temperature range of 0°C to +50°C.

POWER REQUIREMENTS

103.5 V to 126.5 V or 207 V to 253 V, low or high range selected by rear-panel switch. 50 to 400 Hz, 25 watts maximum.

DIMENSIONS AND WEIGHTS

Height	6 in	17.1 cm
Width	9 in	22.8 cm
Depth	15¾ in	40 cm
Net weight	14 lb	6.4 kg
Domestic shipping weight	≈20 lb	≈ 9.1 kg
Export-packed weight	≈31 lb	≈14.1 kg

INCLUDED STANDARD ACCESSORIES

5-ns, 50-Ω RG213 cable (017-0502-00); 50-Ω GR to BNC thruline termination (017-0083-00); right-angle 3-conductor power cord (161-0024-03); 3 to 2-wire adapter (103-0013-00); two instruction manuals (070-0522-00); (power cord for MOD 146B is 161-0031-00).

TYPE 191 CONSTANT-AMPLITUDE SIGNAL GENERATOR $495

TYPE 191 MOD 146B CONSTANT-AMPLITUDE SIGNAL GENERATOR $470

As above, but less cabinet, for mounting in rack adapter.

RACK ADAPTER FOR TYPE 191

Adapts the Type 191 MOD 146B for rackmounting in a 19-inch rack, in only 5¼ inches of panel height. The Type 191 occupies ½-rack width. Two Type 191's can be mounted side-by-side, or alongside other ½-rack width generators, such as the Type 106 Squarewave Generator, 114 Pulse Generator, or Type 115 Pulse Generator. The Type 191 may also be mounted with the ¼-rack width Type 284 Pulse Generator. The Adapter provides forced-air ventilation. Blank panels are available to cover the unused opening when the adapter is not filled. A divider kit is required between instruments, between an instrument and panel, and between panels. Blank panels and divider kits are not included with the Rack Adapter.

RACK ADAPTER (016-0086-01)	$135.00
¾-WIDTH BLANK PANEL (016-0133-00)	$ 9.00
½-WIDTH BLANK PANEL (016-0081-00)	$ 8.00
¼-WIDTH BLANK PANEL (016-0109-00)	$ 5.50
DIVIDER KIT (016-0089-00)	$ 11.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

NEW

2901 Time-Mark Generator 2901

- ***16 MARKER INTERVALS, 4 SINEWAVE FREQUENCIES***
- ***500-MHz SINEWAVE OUTPUT***
- ***CRYSTAL-CONTROLLED OSCILLATOR***

The Type 2901 is a compact, wide-range, time-mark generator. It is CRYSTAL-CONTROLLED and provides 16 MARKER INTERVALS, 4 SINEWAVE FREQUENCIES, and 8 TRIGGER-PULSE INTERVALS.

Marker push buttons are self-canceling so that when any marker button is pushed other buttons are automatically released. More than one marker interval can be obtained at one time by pushing the desired buttons simultaneously. Triggers are time-coincident with the corresponding markers.

The Type 2901 is fully solid state utilizing digital integrated circuits extensively. Outputs are derived from a temperature-stabilized 10 MHz crystal oscillator. A rear-panel connector is provided to allow the Type 2901 to be used as a divider for external oscillator inputs. This instrument offers great versatility for many laboratory or production-line applications.

OUTPUT CHARACTERISTICS

CRYSTAL-CONTROLLED OSCILLATOR

10 MHz ±10 P/M from 20°C to 30°C, 10 MHz ± 20 P/M from 0°C to 50°C. Frequency stability is within 3 P/M in any 24-hour period from 20°C to 30°C. Accuracy and stability specifications are valid only after the instrument has been plugged in for 2 hours and turned on for at least 5 minutes.

MARKER OUTPUT

Positive-going markers with 16 intervals of 0.1 μs to 5 s in 1-5-10 sequence, 0.5 V minimum peak amplitude into 50 ohms.

MARKER AMPLIFIER OUTPUT

Positive- or negative-going markers with 14 intervals of 1 μs to 5 s in 1-5-10 sequence, 25-V minimum amplitude into 1 kΩ.

SINEWAVE OUTPUTS

5-ns, 10-ns, and 50-ns sinewave signals at Marker Output connector with 0.5-V minimum peak to peak amplitude into 50 ohms. 2-ns sinewave signal at Marker Output connector with 0.3-V minimum peak to peak amplitude into 50 ohms.

TRIGGER OUTPUT

Positive-going pulses with 8 intervals of 0.1 μs to 1 s in 1-10 sequence, 0.5-V minimum amplitude into 50 ohms, 1-V minimum amplitude into 1-MΩ.

EXTERNAL CLOCK INPUT

Required signal amplitude is at least 2-V peak to peak for sinewaves, or at least 2-V peak for pulses into 50 ohms. Frequency range is 50 kHz or less, to at least 10 MHz. The 2 ns, 5 ns, 10 ns, and 50 ns sinewaves are operative only when the external oscillator input is 10 MHz.

OTHER CHARACTERISTICS

POWER REQUIREMENTS

90 V to 136 V or 180 V to 272 V, range selected by rear-panel switch. 48 to 440 Hz, approx 30 watts maximum.

DIMENSIONS AND WEIGHTS

Height	4¼ in	10.9 cm
Width	8 in	20.3 cm
Depth	10⅞ in	27.6 cm
Net Weight	7.3 lb	3.3 kg

INCLUDED STANDARD ACCESSORIES

Two 50-Ω BNC coaxial cables (012-0057-01); 50-Ω BNC termination (011-0049-01); two instruction manuals (070-0995-00).

TYPE 2901 TIME-MARK GENERATOR $640

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Power Supply For 160 Series

160A

- ***REGULATED VOLTAGES***
- ***LARGE LOAD CAPACITY***
- ***POWERS UP TO SEVEN INSTRUMENTS***

The Type 160A Power Supply provides the required currents and voltages for one Type 360 Indicator Unit in combination with up to six Type 160-Series Generators. Power capability handles up to five Type 360 Indicator Units, up to five Type 163 Pulse Generators, up to seven Type 162 Waveform Generators, or up to seven Type 161 Pulse Generators.

Electronic regulation compensates for line-voltage variations between 105 and 125 V or 210 and 250 V, and for current-demand differences between instruments.

POWER OUTPUT

REGULATED: +225 V DC at 175 mA with no shunt across the series regulator, increasing to a maximum of 225 mA with a 1500-ohm shunt; +150 V DC at 15 mA; —170 V DC at 125 mA.

UNREGULATED: +300 V DC at 50 mA to 275 mA depending on the current drawn from the regulated +225 V supply; —80 V DC up to 50 mA depending on the current drawn from the regulated —170 V supply; 6.3 V AC at 20 A.

OUTPUT CONNECTORS

Four octal sockets mounted on rear panel.

POWER REQUIREMENTS

350 watts, 50 to 60 Hz. Unit factory wired for 105 V to 125 V (117 V nominal) operation. Transformer taps permit operation at 210 V to 250 V (234 V nominal). Instrument can be ordered factory wired for 210 V-to-250 V operation.

DIMENSIONS AND WEIGHTS

Height	12¼ in	31.1 cm
Width	4⅛ in	10.5 cm
Depth	14⅜ in	36.6 cm
Net weight	20 lb	9.1 kg
Domestic shipping weight	≈26 lb	≈11.8 kg
Export-packed weight	≈44 lb	≈20.0 kg

INCLUDED STANDARD ACCESSORIES

Two inter-unit power cables (012-0016-00); 3-conductor power cord (161-0010-03); 3 to 2-wire adapter (103-0013-00); mounting hardware; instruction manual (070-0220-01).

TYPE 160A POWER SUPPLY $250

OPTIONAL ACCESSORIES

MOUNTING FRAME

Adapts Type 160A to standard 19-inch rack. Mounts up to four Type 160-Series instruments or up to three Type 160-Series instruments and a Type 360 Indicator Unit. Occupies 12¼-inches rack space, order 014-0002-00 ..... $ 8

BLANK PANEL

For above mounting frame, occupies same panel area as one instrument, order 333-0157-00 ..... $ 4.40

U. S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

50-kHz Pulse Generator

161

- ***VARIABLE PULSE DELAY***
- ***VARIABLE WIDTH AND AMPLITUDE***
- ***SEPARATE GATE AND PULSE OUTPUTS***
- ***±50-V OUTPUT AMPLITUDE***

The Tektronix Type 161 Pulse Generator is designed to supply calibrated rectangular output pulses from zero to 50-V amplitude (positive or negative polarity) and 10 μs to 100 ms duration when an external trigger of required voltage is received. An excellent trigger source is the Type 162 Waveform Generator. The 50-V Gate Output has the same duration and timing as the pulse output, but is of fixed amplitude.

When triggered by a negative-going sawtooth, the output pulse and gate can be adjusted to occur at designated points along the sawtooth. A calibrated control indicates output delay as a fraction of the triggering sawtooth duration. Other calibrated controls indicate pulse and gate width (in milliseconds) and pulse amplitude (in volts). When triggered by a positive pulse, the same output waveforms are available. In this instance the delay control functions as a triggering-level selector.

Voltages necessary to operate the Type 161 can be obtained from the Type 160A Power Supply, which can power up to seven Type 161 Generators.

OUTPUT WAVEFORMS

Variable-amplitude positive or negative pulse. Fixed-amplitude positive gate.

OUTPUT CHARACTERISTICS

Risetime—Positive pulse; within 0.5 μs when load capacitance is 10 pF or less, within 0.75 μs for 100 pF or less load capacitance. Negative pulse; within 0.5 μs when load capacitance is 10 pF or less, within 1.5 μs for 100 pF or less load capacitance. Overshoot less than 5%.

Duration—calibrated, variable, 10 μs to 0.1 s.

Delay—continuously variable, 0 to 100% of triggering sawtooth waveform.

AMPLITUDE

Pulse—calibrated, continuously variable, 0 to 50 V, peak. Front panel switch provides positive or negative polarity.

Gate—fixed, 50-V positive, peak to peak minimum.

OUTPUT IMPEDANCE

Positive pulse—1.8 kilohms maximum.

Negative pulse—5 kilohms approximately.

Positive gate—1 kilohm maximum.

TRIGGER REQUIREMENTS

Positive pulse, 3 V peak to peak minimum. Negative-going sawtooth; must include DC bias sufficient to keep voltage positive. Maximum repetition rate, 50 kHz.

POWER REQUIREMENTS

—170 V DC at 17 mA +225 VDC at 22 mA, 6.3 VAC at 1.65 A.

DIMENSIONS AND WEIGHTS

Height	12¼ in	31.2 cm
Width	4⅛ in	10.5 cm
Depth	6⅜ in	16.2 cm
Net weight	3½ lb	1.6 kg
Domestic shipping weight	≈ 8 lb	≈ 3.6 kg
Export-packed weight	≈14 lb	≈ 6.4 kg

INCLUDED STANDARD ACCESSORIES

Inter-unit cable (012-0017-00); mounting hardware; instruction manual (070-0220-01).

TYPE 161 PULSE GENERATOR $165

OPTIONAL ACCESSORIES

MOUNTING FRAME

Adapts Type 161 to standard 19-inch rack. Mounts up to four Type 160-Series instruments or up to three Type 160-Series instruments and a Type 360 Indicator Unit. Occupies 12¼-inches rack space, order 014-0002-00 ..... $ 8

BLANK PANEL

For above mounting frame, occupies same panel area as one instrument, order 333-0157-00 ..... $ 4.40

U.S. Sales Prices FOB Beaverton, Oregon
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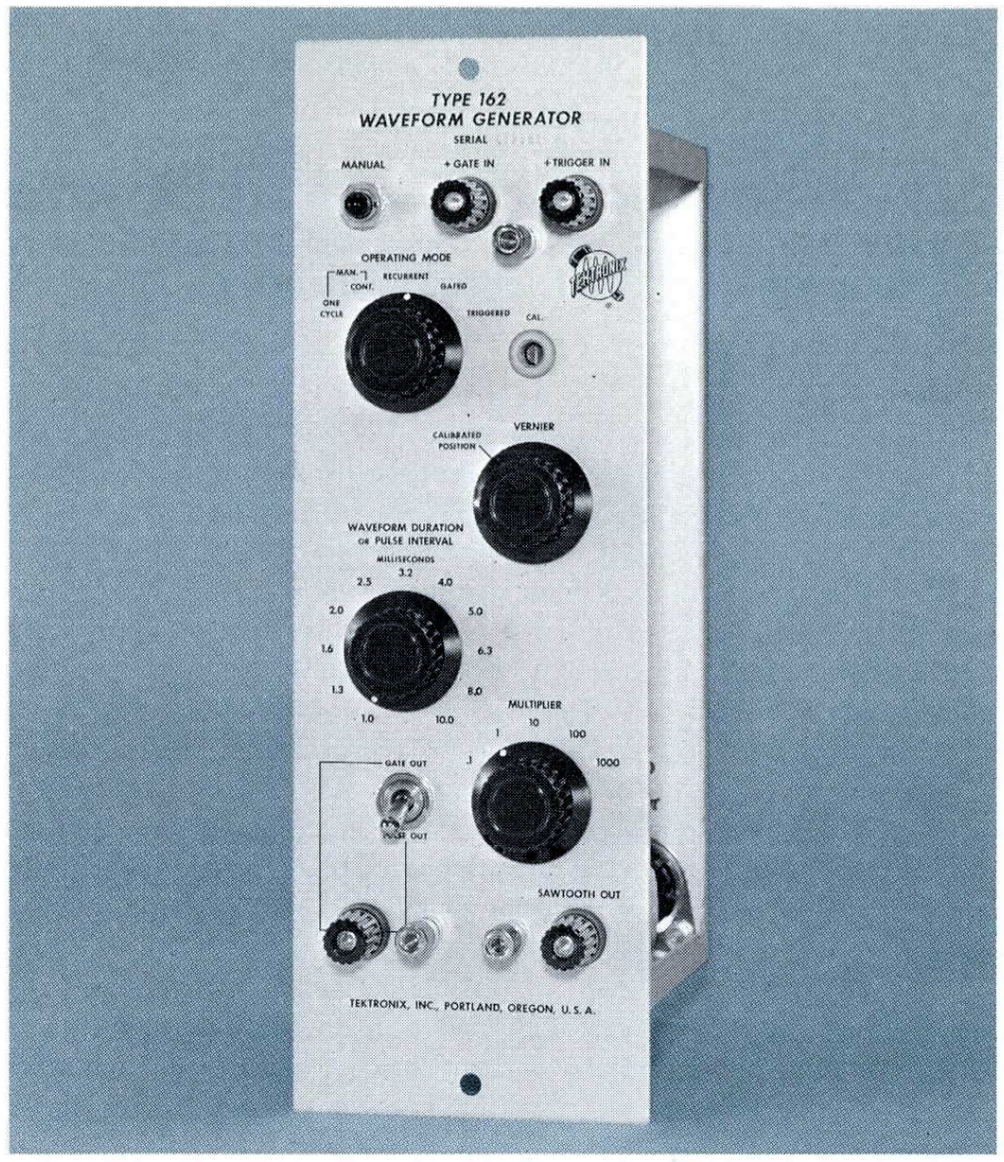
Waveform Generator

162

- ***PULSE OR GATE AND SAWTOOTH OUTPUT***
- ***VARIABLE WAVEFORM DURATION AND PULSE INTERVAL***
- ***5 OPERATING MODES***

The Type 162 Waveform Generator produces three types of calibrated output waveforms. Both the duration and repetition rate of the output waveforms—pulse, gate, and sawtooth—are adjustable. Triggering can occur from an external electrical impulse or by front-panel pushbutton. The unit is designed to operate as a delay generator in conjunction with the Type 161 or Type 163, and to supply a sweep voltage for the Type 360 Indicator Unit. It is useful for initiating chains of events electrically, for controlling their duration and repetition rate, and for generating waveforms recurrently. As such it is a stable repetition rate generator.

Voltages necessary to operate the Type 162 can be obtained from the Type 160A Power Supply, which can power up to seven Type 162 Generators.



OUTPUT WAVEFORMS

Positive pulse, positive gate, and negative-going sawtooth.

OUTPUT CHARACTERISTICS

Pulse Risetime—1 μs or less.

Duration—pulse, 10 μs to 0.05 s; gate and sawtooth, 100 μs to 10 s.

Repetition Rate—0.1 Hz to 10 kHz, recurrent operation.

AMPLITUDE

Pulse and gate are fixed, positive, 50-V peak minimum. Sawtooth decreases linearly with time from $\geq$ +145 V to $\leq$ +25 V.

OUTPUT IMPEDANCE

Approximately 1000 ohms for all outputs.

TRIGGER REQUIREMENTS

Positive pulse—15 V. Positive gate—8 V. Sinewave—6 V RMS, frequency from 5 Hz to 50 kHz.

POWER REQUIREMENTS

—170 V DC at 7 mA, +150 V DC at 1 mA. +225 V DC at 28 mA, 6.3 V AC at 1.7 A.

DIMENSIONS AND WEIGHTS

Height	12¼ in	31.2 cm
Width	4⅛ in	10.5 cm
Depth	6⅜ in	16.2 cm
Net weight	3½ lb	1.6 kg
Domestic shipping weight	≈ 8 lb	≈ 3.6 kg
Export-packed weight	≈14 lb	≈ 6.4 kg

INCLUDED STANDARD ACCESSORIES

Inter-unit power cable (012-0017-00); mounting hardware; instruction manual (070-0220-01).

TYPE 162 WAVEFORM GENERATOR $165

OPTIONAL ACCESSORIES

MOUNTING FRAME

Adapts Type 162 to standard 19-inch rack. Mounts up to four Type 160-Series instruments or up to three Type 160-Series instruments and a Type 360 Indicator Unit. Occupies 12¼-inches rack space, order 014-0002-00 ..... $ 8

BLANK PANEL

For above mounting frame, occupies same panel area as one instrument, order 333-0157-00 ..... $ 4.40

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

500-kHz Pulse Generator

163

- ***0.2-μs RISETIME***
- ***VARIABLE PULSE DELAY***
- ***VARIABLE WIDTH AND AMPLITUDE***
- ***SEPARATE GATE AND PULSE OUTPUT***

The Tektronix Type 163 Pulse Generator is designed to supply rectangular output pulses from 0 to 25 V in amplitude and 1 μs to 10 ms in duration, when an external trigger of required voltage is received. An excellent trigger source is the Type 162 Waveform Generator. The 25-V Gate Output of the Type 163 has the same characteristics as the pulse, but is of fixed amplitude.

When triggered by a negative-going sawtooth, the output pulse and gate can occur at designated points along the sawtooth. A calibrated control indicates output delay as a fraction of the triggering sawtooth duration. Other calibrated controls indicate pulse and gate width (in microseconds) and pulse amplitude (in volts).

The Type 163 operates up to 50% duty cycle at the minimum time setting on any range. With higher multiplier-control settings, the duty cycle can be correspondingly higher. Maximum repetition rate is 500 kHz—with a generated pulse of 1-μs duration.

Voltages necessary to operate the Type 163 can be obtained from the Type 160A Power Supply, which can power up to five Type 163 Generators.

OUTPUT WAVEFORMS

Variable-amplitude positive pulse.
Fixed-amplitude positive gate.

OUTPUT CHARACTERISTICS

Risetime—Within 0.2 μs when load capacitance is 10 pF or less, within 0.25 μs for 100 pF or less load capacitance.

Overshoot can be adjusted to zero.

Duration—calibrated, variable, 1 μs to 10 ms.

Delay—continuously variable, 0 to 100% of triggering sawtooth duration.

Decay Time—0.2 to 0.5 μs.

AMPLITUDE

Pulse—calibrated, continuously variable, 0 to 25 V, peak.
Gate—fixed, positive, 25 V minimum, peak to peak.

OUTPUT IMPEDANCE

Pulse—500 ohms (varies with pulse-amplitude control setting).
Gate—100 ohms.
Minimum load resistance—3.5 kilohms.

TRIGGER REQUIREMENTS

Positive pulse, 2 V peak to peak minimum.
Negative-going sawtooth; must include DC bias sufficient to keep voltage positive. Maximum repetition rate, 500 kHz.

POWER REQUIREMENTS

—170 V DC at 25 mA, +225 V DC at 45 mA. 6.3 V AC 3.6 A.

DIMENSIONS AND WEIGHTS

Height	12¼ in	31.2 cm
Width	4⅛ in	10.5 cm
Depth	6⅜ in	16.2 cm
Net weight	3½ lb	1.6 kg
Domestic shipping weight	≈ 8 lb	≈ 3.6 kg
Export-packed weight	≈14 lb	≈ 6.4 kg

INCLUDED STANDARD ACCESSORIES

Inter-unit power cable (012-0017-00); mounting hardware; instruction manual (070-0220-01).

TYPE 163 PULSE GENERATOR $165

OPTIONAL ACCESSORIES

MOUNTING FRAME

Adapts Type 163 to standard 19-inch rack. Mounts up to four Type 160-Series instruments or up to three Type 160-Series instruments and a Type 360 Indicator Unit. Occupies 12¼-inches rack space, order 014-0002-00 ..... $ 8

BLANK PANEL

For above mounting frame, occupies same panel area as one instrument, order 333-0157-00 ..... $ 4.40

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Indicator Unit For 160 Series

360

- **DC-to-500 kHz VERTICAL BANDWIDTH**
- **0.05 V/DIV-to-50 V/DIV DEFLECTION FACTOR**

The Type 360 Indicator Unit in combination with the Type 160-Series Instruments becomes an integral building block in a complex sequence control and monitoring system.

The compact indicator contains a flat-faced, 3-inch cathode-ray tube, accelerating-voltage supply, horizontal amplifier, vertical amplifier and a calibrated vertical attenuator, among other features. It is designed to receive its sweep and unblanking voltages from a Type 162 Waveform Generator.

Any source of proper voltage and waveforms can power the indicator. The Type 160A Power Supply is recommended for applications that require a compact rack-mounted combination. In system use, up to 5 Type 360 Indicator Units can operate from a single Type 160A Power Supply.

VERTICAL DEFLECTION

BANDWIDTH

DC to 500 kHz at 3-dB down.

DEFLECTION FACTOR

0.05 V/div, 0.5 V/div, 5 V/div and 50 V/div. Continuously variable between steps.

INPUT RC

1 megohm paralleled by approx 40 pF.

MAXIMUM INPUT VOLTAGE

600 V combined DC + peak AC.

HORIZONTAL DEFLECTION

WAVEFORMS REQUIRED

Positive or negative-going sawtooth: 110 to 150 V excursion within the limits of —95 V to +170 V.

Unblanking gate: 45 to 75 V positive, same duration as the sawtooth.

BANDWIDTH

DC to 75 kHz at 3-dB down.

CRT

TEKTRONIX CRT

A flat-faced 3-inch cathode-ray tube provides a bright trace. Accelerating potential is 1.5 kV. A P2 phosphor is normally supplied, P1, P7, P11, or P31 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. Z-axis input is DC-coupled to the grid and requires at least 45 V to unblank CRT.

GRATICULE

External, illuminated, marked in eight vertical and ten horizontal one-fourth inch major divisions. Center lines are further marked in five minor divisions per major division.

OTHER CHARACTERISTICS

POWER REQUIREMENTS

+300 V DC at 20 mA unregulated; +225 V DC at 35 mA regulated; —170 V DC at 23 mA regulated; 6.3 V AC at 3.5 A.

INCLUDED STANDARD ACCESSORIES

Inter-unit power cable (012-0016-00); smoke-gray filter (378-0550-00); mounting hardware; instruction manual (070-0220-01).

DIMENSIONS AND WEIGHTS

Height	12¼ in	31.2 cm
Width	4⅛ in	10.5 cm
Depth	14 in	35.6 cm
Net weight	9¾ lb	4.4 kg
Domestic shipping weight	≈16 lb	≈ 7.3 kg
Export-packed weight	≈26 lb	≈11.8 kg

TYPE 360 INDICATOR $330

OPTIONAL ACCESSORIES

MOUNTING FRAME

Adapts Type 360 to a standard 19-in rack. Mounts up to four Type 360 Indicator Units or up to three Type 160-Series instruments and one Type 360. Occupies 12¼ inches of rack space, order 014-0002-00 ..... $8

BLANK PANEL

For above mounting frame, occupies same panel area as one instrument, order 333-0157-00 ..... 4.40

C-30A CAMERA

f/1.9 lens, magnification variable from 1.5:1 to 0.7:1; Polaroid Land* Pack-Film Back, order C-30A-P $480

Type 360 to C-30A Camera Adapter, order 016-0241-00 . $16

PROBES

P6006 10X Probe Package, order 010-0125-00 ..... $29.00

P6007 100X Probe Package, order 010-0134-00 ..... $29.00

P6027 1X Probe Package, order 010-0070-00 ..... $16.50

*Registered Trademark Polaroid Corporation

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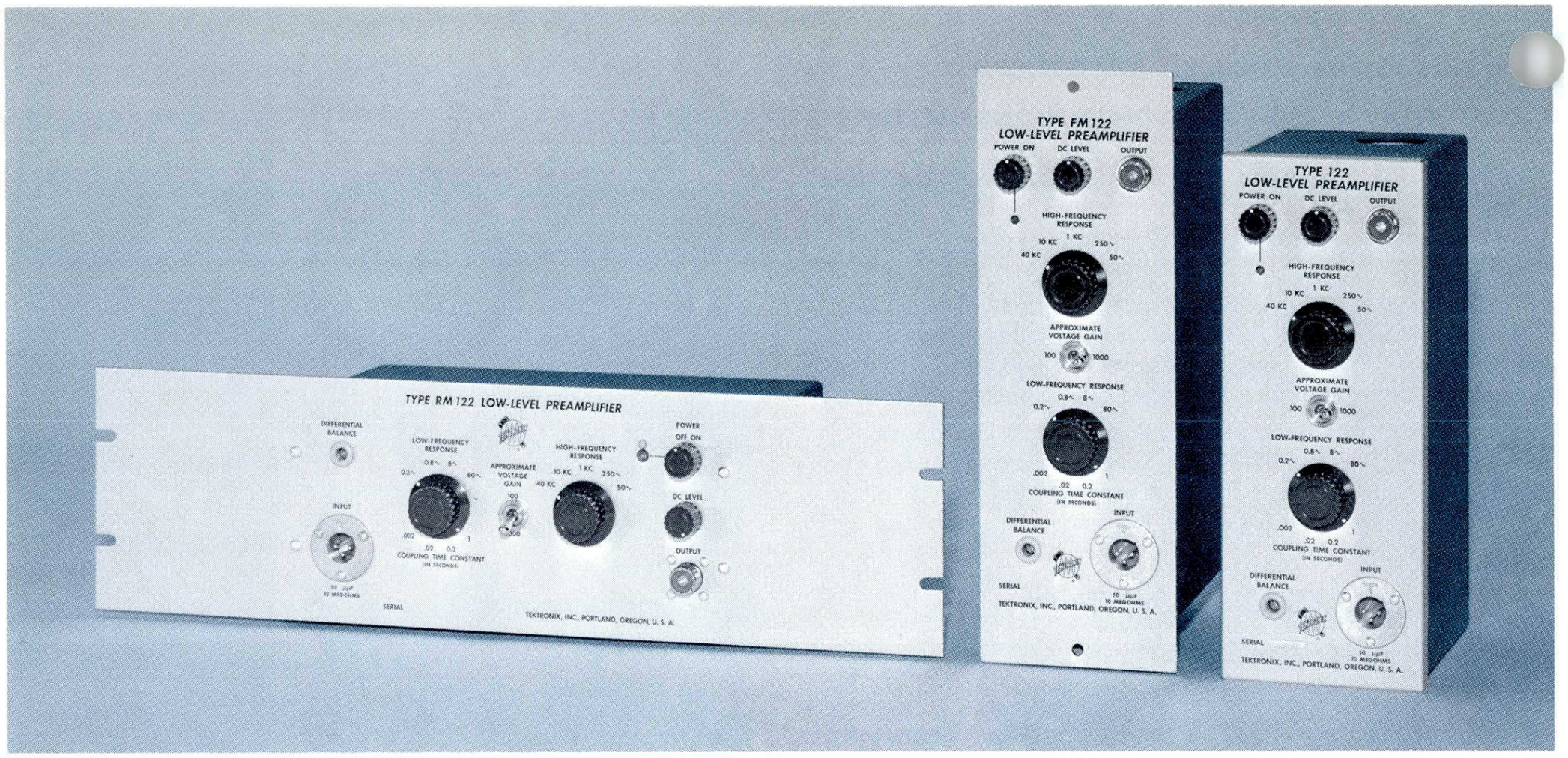
122 Low-Level Preamplifier FM122/RM122



- ***APPROXIMATE VOLTAGE GAIN: 100 OR 1000***
- ***SINGLE ENDED OR DIFFERENTIAL INPUT***

The Tektronix Type 122, FM122, or RM122 Low-Level Preamplifier is a compact 3-stage amplifier extending the usefulness of the oscilloscope into the microvolt region. The Type 122 is especially useful in biological research and other applications that require the amplification of microvolt signals.

BANDWIDTH
0.2 Hz to 40 kHz. High and low-frequency —3 dB points can be set by front panel switches.

APPROXIMATE VOLTAGE GAIN
100 or 1000, selected by a toggle switch.

INPUT RC
10 megohms paralleled by approximately 50 pF.

COMMON-MODE REJECTION RATIO (CMRR)
Better than 10,000:1 between 5 Hz and 40 kHz. Maximum common-mode input signal: 4 V.

SIGNAL OUTPUT
20 V (peak to peak) maximum in high gain position, 10 V (peak to peak) maximum in low gain position; AC signals up to 0.02 V (gain 1000) or 0.1 V (gain 100) and DC levels up to ±0.1 V (either gain setting) can be applied before waveform distortion occurs. Output impedance is approximately 1000 ohms.

NOISE LEVEL
1 to 5-μV RMS referred to input with input grounded.

POWER REQUIREMENTS
+135 V at 5 mA, —90 V at 4 mA, and 6.3 V at 0.9 A, applied through a standard octal plug. The Type 122 can be powered by the Type 125 Power Supply or by batteries. Batteries are not included with the Type 122.

INCLUDED STANDARD ACCESSORIES
Output cable (012-0003-00); input plug (131-0013-00); two instruction manuals (070-0246-00). Type FM122 and RM122 include mounting hardware.

DIMENSIONS AND WEIGHTS—TYPE 122

Height	10¼ in	26.0 c
Width	4⅛ in	10.5 cm
Depth	7⅛ in	18.1 cm
Net weight	4¼ lb	1.9 kg
Domestic shipping weight	≈ 9 lb	≈ 4.1 kg
Export-packed weight	≈13 lb	≈ 5.9 kg

DIMENSIONS AND WEIGHTS—TYPE FM122
Electrically identical to Type 122, but designed to mount vertically in a standard rack with associated instruments. Can be mounted directly or mounted by Tektronix mounting frame, (see Type 125 catalog page for mounting frame information).

Height	12¼ in	31.2 cm
Width	4⅛ in	10.5 cm
Depth	7 in	17.8 cm
Net weight	4¾ lb	2.2 kg
Domestic shipping weight	≈ 9 lb	≈ 4.1 kg
Export-packed weight	≈13 lb	≈ 5.9 kg

DIMENSIONS AND WEIGHTS—TYPE RM122
Electrically identical to Type 122, but designed for horizontal mounting in standard 19-inch rack.

Height	5¼ in	13.4 cm
Width	19 in	48.3 cm
Depth	7 in	17.8 cm
Net weight	4¾ lb	2.2 kg
Domestic shipping weight	≈11 lb	≈ 5.0 kg
Export-packed weight	≈18 lb	≈ 8.2 kg

TYPE 122 PREAMPLIFIER **$165**
TYPE FM122 without mounting frame **$170**
TYPE RM122 . . . . . **$170**

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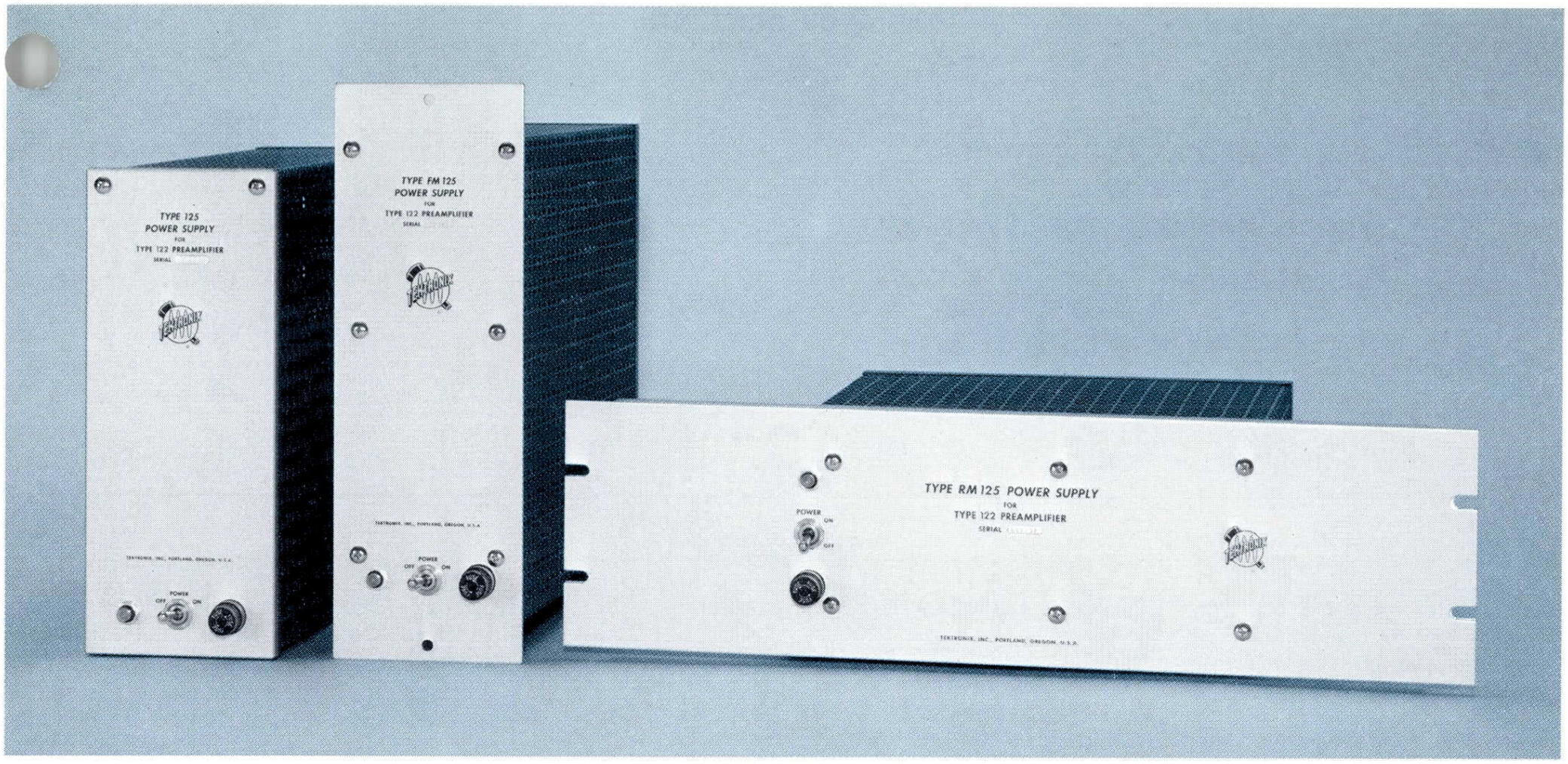
Power Supply for 122 Amplifier FM125/RM125



- ***POWERS UP TO FOUR TYPE 122 AMPLIFIERS***
- ***ELECTRONIC VOLTAGE REGULATION***

POWER OUTPUT

Supply voltages with corresponding ripple: +135 V, <3 mV; −90 V, <2 mV; −6 V, <5 mV. Voltage stability assured by regulated heater supply.

POWER REQUIREMENTS

110 watts, 50 to 60 Hz. Instrument factory wired for 105 V-to-125 V (117 V nominal) operation. Transformer taps permit operation at 210 V to 250 V (234 V nominal). Can be ordered factory wired for 210 V-to-250 V operation.

INCLUDED STANDARD ACCESSORIES

Four 36-inch interconnecting cables (012-0065-00); 3-conductor power cord (161-0010-03); 3 to 2-wire adapter (103-0013-00); two instruction manuals (070-0246-00). In addition, Types FM125 and RM125 include mounting hardware.

DIMENSIONS AND WEIGHTS—TYPE 125

Height	10¼ in	26.0 cm
Width	4⅛ in	10.5 cm
Depth	10⅜ in	26.4 cm
Net weight	14¾ lb	6.7 kg
Domestic shipping weight	≈21 lb	≈ 9.6 kg
Export-packed weight	≈40 lb	≈18.2 kg

DIMENSIONS AND WEIGHTS—TYPE FM125

Electrically identical to Type 125, but designed to mount vertically in a standard rack with associated instruments. Can be mounted directly or mounted by Tektronix mounting frame.

Height	12¼ in	31.2 cm
Width	4⅛ in	10.5 cm
Depth	13½ in	34.3 cm
Net weight	14½ lb	6.6 kg
Domestic shipping weight	≈21 lb	≈ 9.6 kg
Export-packed weight	≈40 lb	≈18.2 kg

DIMENSIONS AND WEIGHTS—TYPE RM125

Electrically identical to Type 125, but designed for horizontal mounting in a standard 19-inch rack.

Height	5¼ in	13.3 cm
Width	19 in	48.3 cm
Rack depth	13½ in	34.3 cm
Net weight	16½ lb	7.5 kg
Domestic shipping weight	≈28 lb	≈12.7 kg
Export-packed weight	≈40 lb	≈18.2 kg

TYPE 125 POWER SUPPLY $330
TYPE FM125 POWER SUPPLY $335
TYPE RM125 POWER SUPPLY $335

OPTIONAL ACCESSORIES

MOUNTING FRAME FOR TYPE FM125

Fits any standard 19-inch rack and is fastened to the front of the rack by four screws. Capacity is four of any combination of Type FM122 Preamplifier, Type FM125 Power Supply, Type 360 Indicator, and Type 160-Series Units. (Note: Because the Type FM122 Preamplifier has high sensitivity, it is recommended that it be mounted at least 4 inches to the left of the Type FM125 Power Supply, order 014-0002-00 ..... $8

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Camera Reference

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GLOSSARY

beam splitter—A device such as a prism or half-silvered mirror which splits a light beam into 2 or more beams not necessarily equal in intensity.

bezel—The flange or cover used for holding an external graticule or cathode-ray tube cover in front of the cathode-ray tube in an oscilloscope.

cable release—a cable provided for remote actuation of a camera shutter.

camera adapter—a mounting frame used to attach a camera to an oscilloscope.

collimate—To render parallel.

definition—The degree of clarity of reproduction of an object by an optical system.

dichroic—Exhibiting the quality of selective reflection and transmission of light as a function of wavelength.

fiber optics—A system for transmitting an image by means of a large number of transparent fibers. Each fiber carries only one element of the image so that the image is a mosaic rather than a continuous picture.

parallax—The apparent displacement of an observed object due to the angle of observation.

postfogging—A technique of increasing the apparent sensitivity of film by a uniformly controlled exposure to light after the image producing exposure.

prefogging—A technique of increasing the apparent sensitivity of film by a uniformly controlled exposure to light before the image producing exposure.

resolving power—The degree to which a system or a device distinguishes fineness of detail.

Tektronix cameras, component parts and accessories are specifically designed to solve a wide range of oscilloscope trace-recording needs. Of the many design considerations made during the development of a Tektronix oscilloscope-camera system, one of the most important considerations is ease of operation. The attention given to this objective is evident from the improvements of the New C-50, C-51 and C-70 Cameras. The ability of a particular user to photograph a given event is primarily dependent upon the selection of the oscilloscope-camera system and secondarily, his ability to apply certain photographic techniques.

The various Tektronix cameras can be classified into four groups. These groups are: C-50 and C-51 (recommended for the 7000 Series); C-70 (recommended for the 5000 Series and Type 576 Curve Tracer); the C-12 and C-27 (recommended for the 500 Series); and the C-30A and C-31 (recommended for the 300 and 400 Series). The C-10 is a special-purpose camera designed for use with the Tektronix Type 611 Storage Display Unit. When a camera is recommended for a particular oscilloscope, that is not to imply that the camera would not be suitable for use with other instruments. The application would be the primary determining factor.

The C-50, C-51 and C-70 are compact cameras with features not available on other cameras, to add to photographic ease and convenience. These cameras are focused by merging two bars of light which are projected from the camera to the CRT. The exposure photometer projects the virtual image of a spot of light into the plane of the CRT where the spot can be matched to the trace intensity. When the camera is properly focused, a locking mechanism secures the aperture and shutter speed controls so that if one is moved, the other tracks to maintain the correct exposure ratio.

Factors to consider in choosing the most appropriate camera include: lens type, CRT phosphor, type and size of print desired, ability to up-grade or add to a present camera, type of viewing, compatibility with different oscilloscopes, and writing speed requirements. These factors are discussed below.

VIEWING

All cameras may be easily swung away from the display area for wide-angle viewing. The C-12, C-27, C-50, C-51, and C-70 Cameras also provide a comfortable viewing tunnel, through which the display may be viewed without interference from ambient light. The C-12 features a beam-splitting mirror, which simulates a viewing position directly in front of the CRT, and thus eliminates parallax. A projected graticule is available for use with the C-12 in applications where parallax is to be further reduced, or a special-purpose graticule or mask is needed.

CAMERA FLEXIBILITY AND COMPATIBILITY

Tektronix cameras are designed to offer maximum flexibility and compatibility. These two considerations are so broad the information is presented in a chart form for ease of understanding. Please see the component pages in this section. Your Field Engineer will be pleased to assist you in those instances wh additional information is required.

Camera Reference

PICTURE SIZE

For either Polaroid[1] Land or conventional films, the exposable area of the film must be at least as large as the image from the lens. Image size will depend on the object-to-image ratio of the camera lens and on the size of the oscilloscope display. For example, the Graflok[2] Back with 120 or 620 roll film would probably not be used with a 1:0.85 lens and a 10-cm wide oscilloscope display. This is because the image of the display is 8.5 cm wide and the exposable area (long dimension) of the film is only 7.8 cm maximum (it can be as short as 5.7 cm, depending on film format). The film size should be at least 5 mm larger than the size of the image to allow for normal tolerances in the construction of the Camera Backs and for the position of the film in the back.

ASA RATINGS, FILM AND BACK TYPES

Polaroid Pack Backs, Roll Backs and Graflok Backs may be interchanged on each camera.

Polaroid films can also be used in a Polaroid 4 x 5 film holder with the 4 x 5 Graflok Back. This combination, used with Type 57 film (3000 speed), a 1:1 lens, and a C-27 Main Frame will give full-size records of graticule areas as large as 8 x 10 cm. A Standard C-27 Camera (1:0.85 lens) equipped in the same way will make a complete record of a 10 x 10-cm graticule.

If you want to obtain a negative from which a number of prints can be made, either Type 55 P/N film (which comes in Polaroid Land 4 x 5, only) or conventional film is satisfactory.

Conventional cut film and 120 roll film can be used with either the 4 x 5 or 2¼ x 3¼ Graflok Back and the proper holder or adapter. A number of film types, manufactured by Eastman Kodak, Agfa, Ansco, and others, are available in both forms, at ASA speeds from 64 to 1250.

A detailed list of film types and characteristics of these and other films not mentioned here can be obtained from the respective manufacturer.

Polaroid Type 47 and Type 107 (roll film and pack film, respectively) each have an ASA equivalent exposure index of 3000. Polaroid Type 410 ASA 10,000 roll film is especially suited for high-speed photography. Each film type has 8 exposures, and develops in 10 seconds. Continuous-tone slides can be made using Polaroid Type 46 or 46-L; each film type is on an 8-exposure roll and develops in 2 minutes. Roll film develops inside the film back; pack film develops outside.

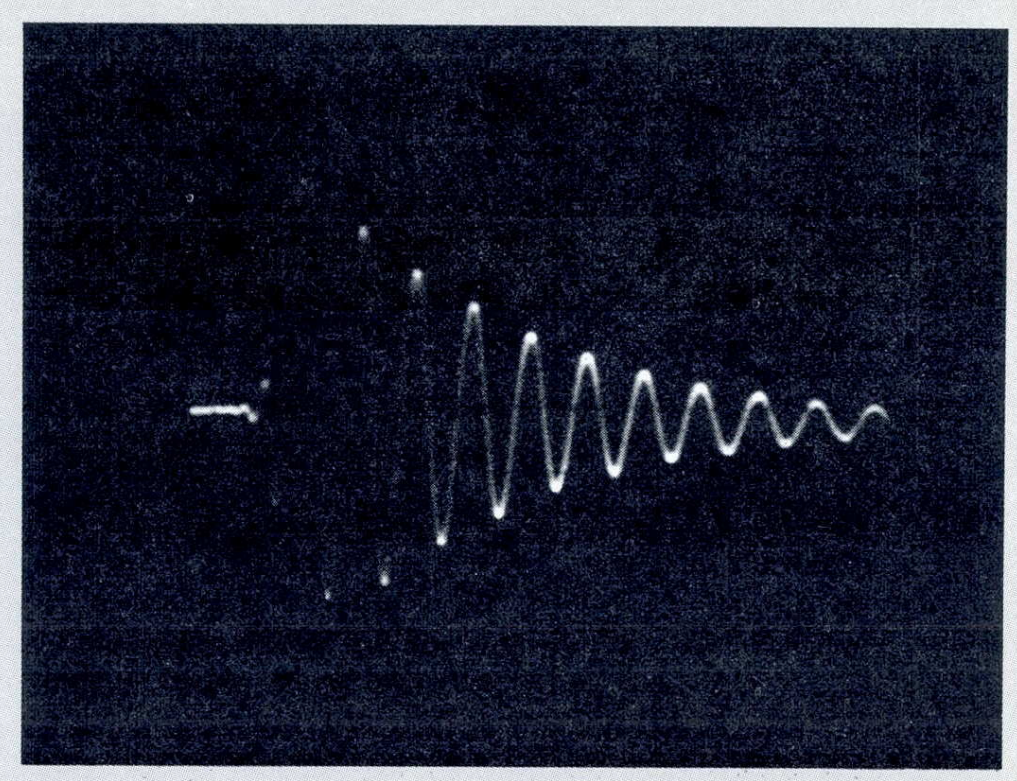
ASA exposure ratings are measured under a specific set of conditions. Oscilloscope exposures differ from these conditions such that ASA ratings do not accurately apply to oscilloscopes. However, the writing speed of ASA 10,000 may generally be expected to be approximately 2 to 2.5 times that of ASA 3000 for oscilloscope photography.

PHOTOGRAPHIC WRITING SPEED

Photographic writing speed describes the ability of a particular camera, film, oscilloscope, and phosphor to record fast moving traces. The writing speed figure expresses the maximum single event spot velocity (usually in centimeters per microsecond) which may be recorded on film.

The illustration below shows one way in which writing speed can be measured to determine if a particular system has the ability to record an important single-sweep display which will be difficult if not impossible to repeat. There is displayed a single trace of a damped sinewave whose frequency and amplitude is such that the rapidly rising and falling portions of the first cycle or two fail to record. The peak to peak amplitude of the sinewave should be three to four times as great as the horizontal distance occupied by one cycle.

The writing speed capability of the oscilloscope is determined as follows: mask out the sinewave peaks on the photograph leaving the central one-third visible. View the photograph while backlighted. Starting from the left, find the first rapidly rising or falling portion of the damped sinewave which is discernible. Let D represent the vertical distance in centimeters between the peaks which are connected by this portion. The writing speed in centimeters per microsecond is calculated by:



Photographic writing speed = 3.14 Df where f is the frequency of the damped sinewave in megahertz.

Although the writing speed is an important characteristic of the oscilloscope, it does not completely describe the ability of the oscilloscope to present detailed information.

Writing speeds have been specified for certain Tektronix oscilloscopes such as the Type 454 and the New 7000 Series. The specification represents the minimum photographic writing speed which can be expected without employing special photographic techniques such as prefogging and post-fogging. In addition, a considerable safety margin is provided for the oscilloscope users since the writing speed specification is based upon minimal performance, not average. The oscilloscope-camera user, by selecting either the Type 454 or one of the 7000-Series Oscilloscopes, knows in advance the minimum writing speed he may expect. The writing speed of other oscilloscope-camera systems should, generally, be determined experimentally on an individual basis.

LENSES

Each of these lens systems were specifically designed for oscilloscope applications. Their essential differences are in their ability to photograph extremely dim traces such as those produced in single-sweep applications at the highest sweep rates, and their angular coverage, or ability to photograph large or small displays.

Two factors which should be considered in selecting a lens are the f number and the object-to-image ratio, since writing speed is directly dependent upon both. Writing speed for a given system can always be expected to increase as the f number decreases and the object-to-image ratio increases.

[1]Registered Trademark Polaroid Corporation.
[2]Registered Trademark Graflex, Inc.

Camera Reference

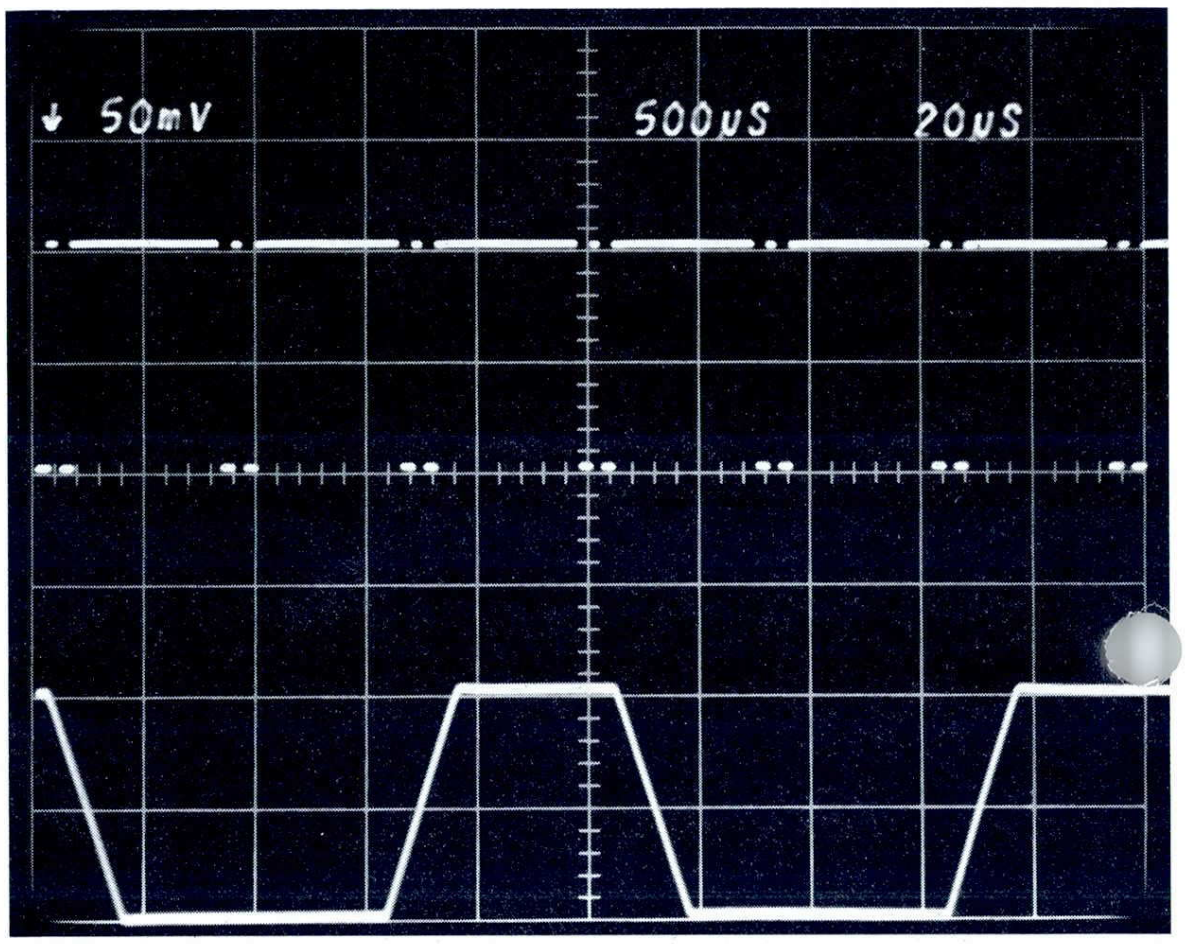
There are basically five different lenses which are available for the C-12 and C-27 cameras which add to the flexibility of these cameras. The f number and object-to-image ratios are: standard general-purpose f/1.9-1:0.85 and f/1.9-1:0.7, high speed f/1.9-1:0.5, precise full-size image and high writing speed f/1.4-1:1 and the extra-high writing speed f/1.3-1:0.5. The C-51 has an f/1.2 lens with an object-to-image ratio of 1:0.5. This is the best light-gathering lens available in any Tektronix camera. The camera and the 7000 Series have been designed to provide maximum writing speed with P31 phosphor; little, if any writing speed advantage will be gained with P11 phosphor.

The C-50, C-51, C-70, C-30A and C-31 do not have the lens flexibility of the C-12 and C-27 since the lenses of these cameras are fixed. The individual specification page for each camera contains a complete description of the camera's lens system.

CRT SELECTION

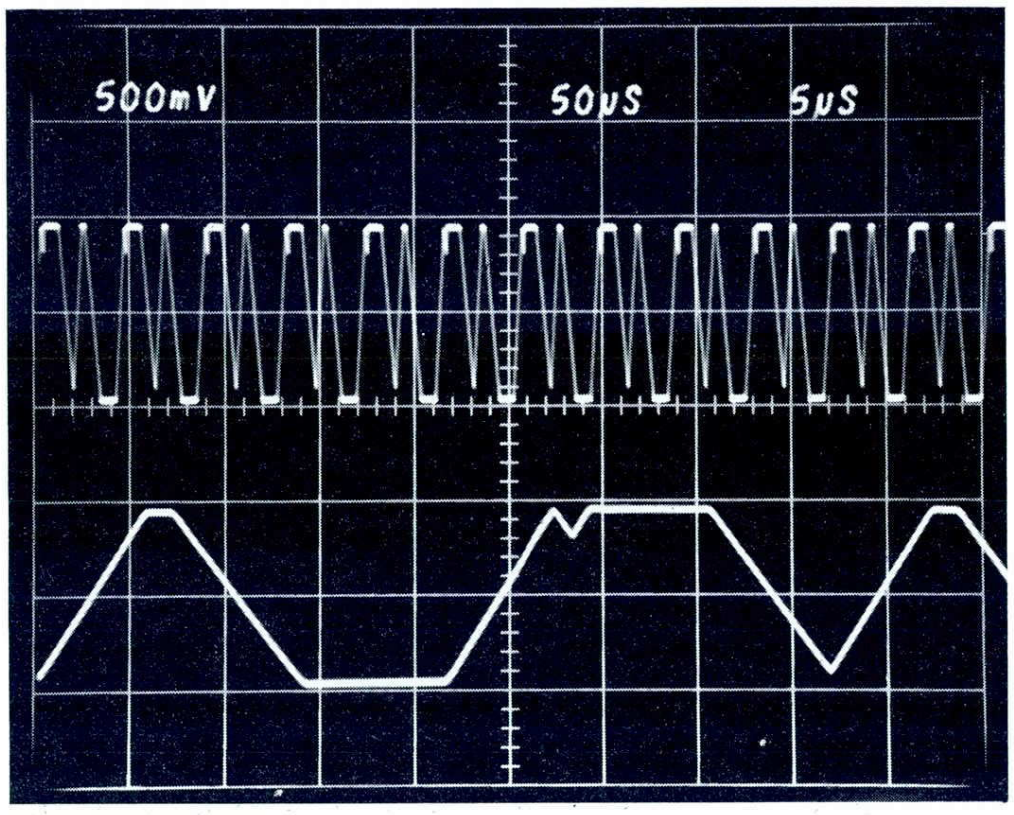
There are a great number of phosphor types presently available to the purchaser of a cathode-ray oscilloscope. Each of these phosphors has certain advantages and disadvantages compared to the others. There is no one phosphor which is best for all applications.

The catalog description of each oscilloscope indicates the phosphor normally supplied. However, phosphors may be ordered which would be more suitable for particular requirements. The phosphor data chart in the General Oscilloscope Reference Section will help in your selection.



PRECISE FULL-SIZE IMAGE & HIGH WRITING SPEED

f/1.4, 1:1 object-to-image ratio . . . for precise full-size records . . . measurements can be scaled directly off photograph with maximum resolution, writing speed 1.75X general-purpose lens. Taken with C-27 and 7000-Series Oscilloscope, in alternate sweep mode.

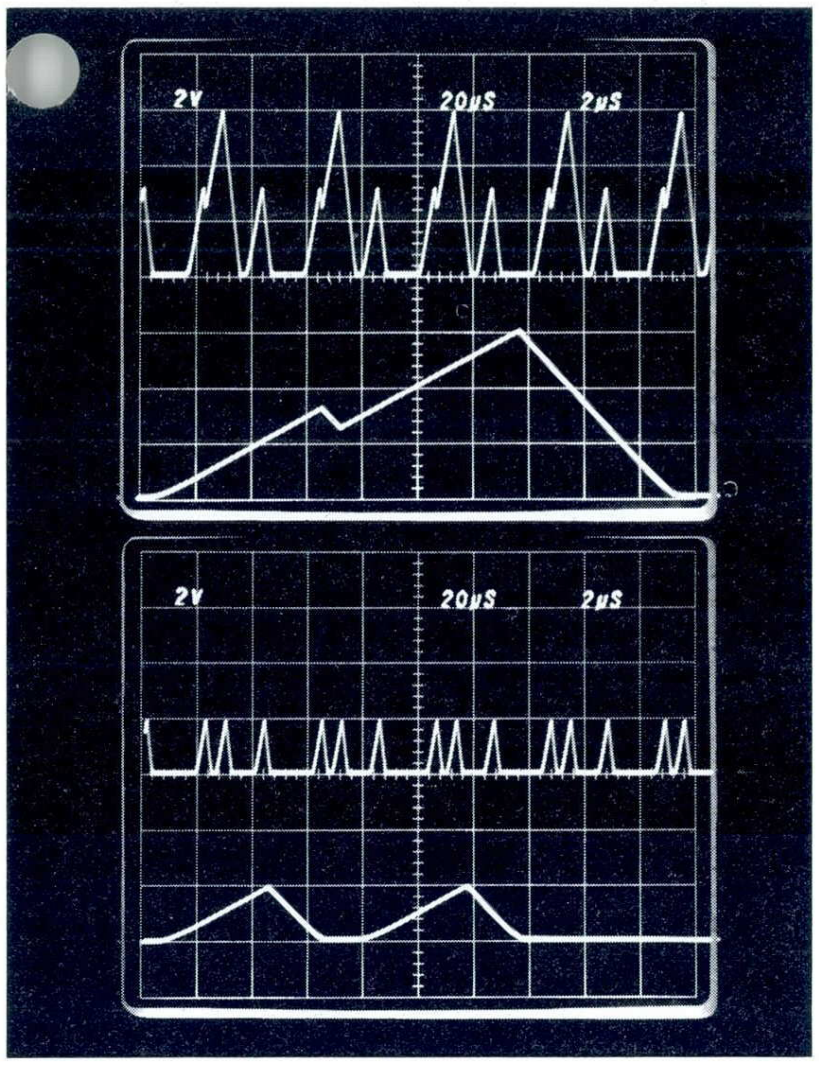


GENERAL PURPOSE

f/1.9, 1:0.85 object-to-image ratio . . . image brightness sufficient for most applications. When photographing 8 x 10-cm graticules, or 10 x 10-division graticules provides the largest size image that will still fall within the maximum recording area of 3¼ x 4¼ size Polaroid film. Taken with C-27 and 7000-Series Oscilloscope, in alternate sweep mode.

Photos on these two pages reproduced in the actual size of the prints.

Camera Reference

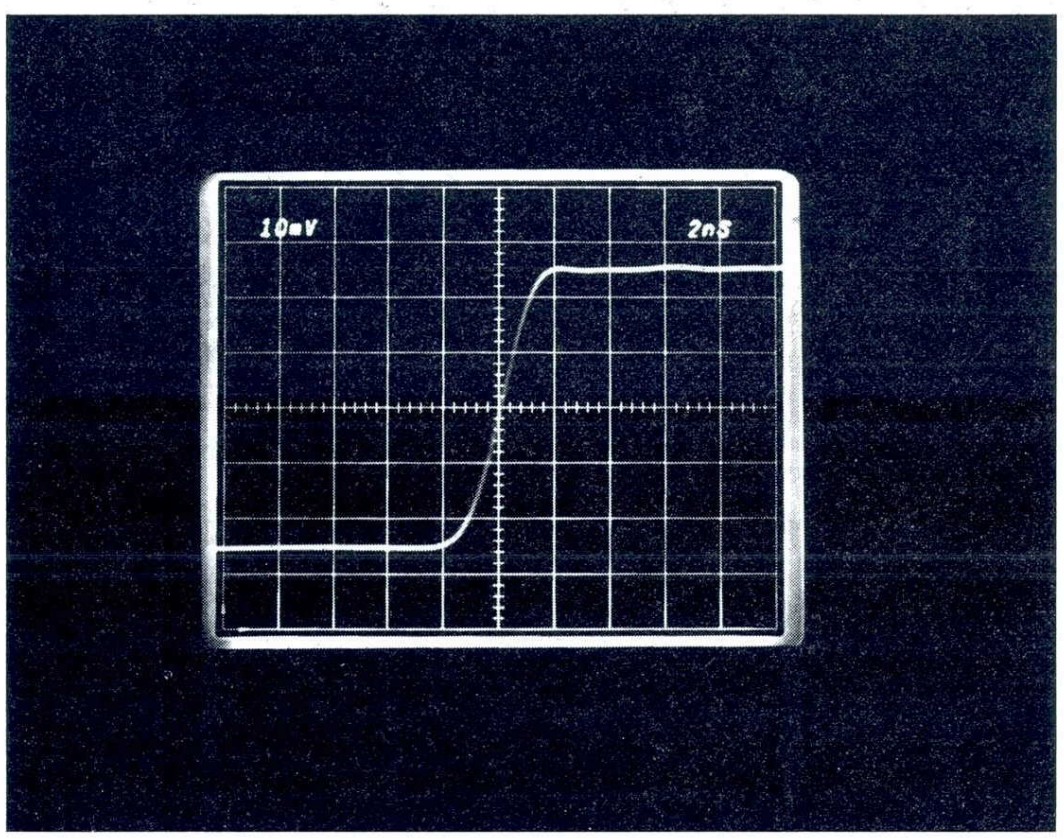


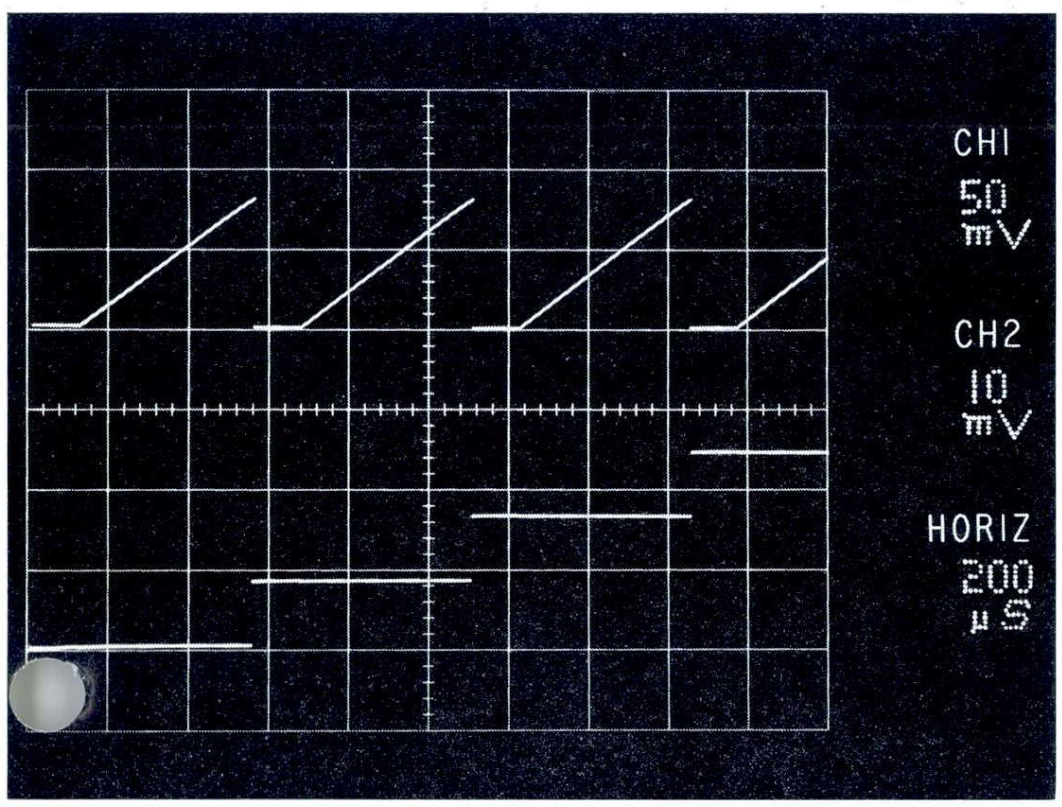
FILM ECONOMY AND HIGH WRITING SPEED

f/1.3, 1:0.5 object-to-image ratio . . . efficient use of film combined with high-writing speed lens. Taken with C-27 and 7000-Series Oscilloscope, using alternate sweep mode.

MAXIMUM WRITING SPEED LENS

f/1.2, 1:0.5 object-to-image ratio . . . for applications where writing rate is the prime consideration. Repetitive event photographed with C-51 and 7704 Oscilloscope. Single-sweep writing speed is 3300 cm/μs.





RECORDS READOUT AND DISPLAYS ON 6½-INCH CRT'S

f/1.9, 1:0.575 object-to-image ratio . . . designed especially for oscilloscope with 6½-inch CRT's and fiber-optic readout. Taken with C-70 and 5030 Oscilloscope.

Camera Components

OSCILLOSCOPE/CAMERA ADAPTERS
($16 each)

OSCILLOSCOPE TYPE	RECOMMENDED CAMERA	C-12 ADAPTER PART NUMBER	C-27 ADAPTER PART NUMBER	C-30A & C-31 ADAPTER PART NUMBER
310A	C-30A			016-0241-00
317	C-30A			016-0241-00
321A	C-30A			016-0242-00
360	C-30A			016-0241-00
422	C-30A			integral
453	C-30A or C-31			integral
454	C-30A or C-31			integral
491	C-30A			integral
502A	C-27-547 or C-27G	016-0226-01	016-0225-02	016-0243-00
503	C-12 or C-27			
504	C-12 or C-27			
515A	C-12			
516	C-12			
519	C-27-662R		integral	
520	C-27-549		016-0225-02	
521	C-27-549		016-0225-02	
522	C-27-549		016-0225-02	
528	C-27	016-0263-00	016-0249-01	016-0248-00
529	C-27	016-0217-00*	016-0224-00	016-0244-00
535A	C-12	016-0226-01	016-0225-02	016-0243-00
544	C-12 or C-27			
545B	C-12 or C-27			
546	C-12 or C-27			
547	C-12 or C-27			
549	C-12			
551	C-12			
556	C-12 or C-27			
561B	C-12 or C-27	016-0217-00	016-0224-00	016-0244-00
564B	C-12 or C-27			
565	C-27-547 or C-27G	016-0226-01	016-0225-02	016-0243-00
568	C-27	016-0217-00	016-0224-00	016-0244-00
575	C-12	016-0226-01	016-0225-02	016-0243-00
576**	C-70	See Adapter-frame/corrector lens		
585	C-27-662R	016-0226-01	016-0225-02	016-0243-00
601	C-30A	016-0263-00	016-0249-01	016-0248-00
602	C-30A	016-0263-00	016-0249-01	016-0248-00
647A	C-27-662R		016-0223-00	
5030**	C-70	See Adapter-frame/corrector lens		
5031**	C-70			
7503**	C-50	016-0263-00	016-0249-01	016-0248-00
7504**	C-50			
7704**	C-51			
some Hewlett-Packard	call Tektronix Field Office or Representative	016-0229-00	016-0228-00	
some Fairchild DuMont			016-0227-00	

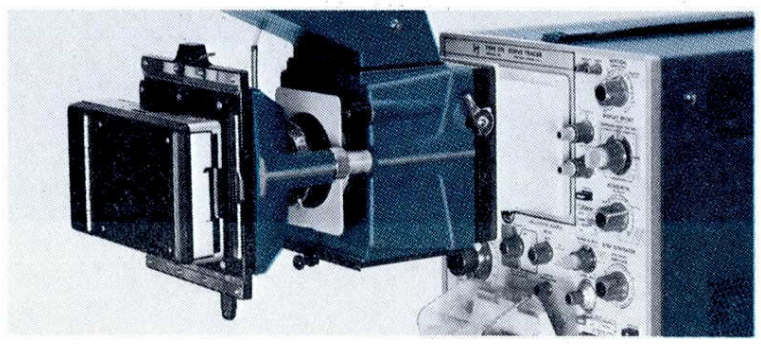
*Requires slight modification to Type 529.

**The adapter for the recommended camera is an integral part of the camera.

ADDITIONAL ADAPTERS

ADAPTER-FRAME/CORRECTOR LENS

Adapter bezel for mounting Types C-12, C-27, or C-30A Cameras to the Type 576, or 5000-Series Oscilloscopes. The adapter system consists of a mounting frame and a corrector lens. With the standard C-12 or C-27 lens (f/1.9—1:0.85) the corrector lens reduces the effective magnification to about 1:0.45. The adapter frame accepts the standard camera adapters (016-0226-01 (C-12) or 016-0225-02 (C-27) or 016-0243-00 (C-30A only); order separately. NOTE: not recommended for C-31 because of its 1:0.5 object-to image ratio.
Adapter-frame/corrector lens, order 016-0264-00 ..... $35



Corrector lens in place. Adapter frame secured to Type 576 accepts C-12 or C-27 with standard 5-inch round CRT adapter.

Adapter bezel for mounting the Type C-12 Camera to the 7000-Series Oscilloscopes. Adapter can also be used with Types 601, 602, and 528, order 016-0263-00 ..... $16

Adapter bezel for mounting the Type C-27 Camera to the 7000-Series Oscilloscopes. Adapter can also be used with Types 601, 602 and 528, order 016-0249-01 ..... $16

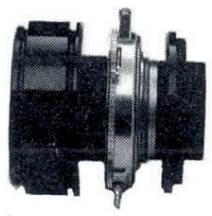
The C-30A and C-31 Adapters and light seals are supplied as integral parts of each camera. For additional adapters and light seals (both are required) order as follows:

INST.	ADAPTER	PRICE	LIGHT SEAL	PRICE
422	122-0928-00	$16.00	354-0279-00	$.40
491	122-0928-00	$16.00	354-0279-00	$.40
453	122-0928-00	$16.00	354-0280-00	$.80
454	122-0928-00	$16.00	354-0280-00	$.80

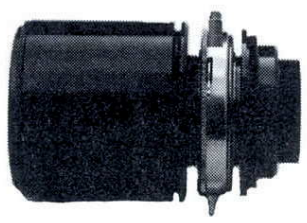
Camera Components

MECHANICAL SHUTTER/LENS FOR C-12 AND C-27 CAMERAS

Shutter speeds from 1 to 1/50 second, plus Bulb and Time.

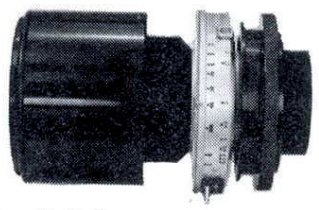


f/1.9—1:0.7
Film Economy
Medium Writing Rate
Pi Alphax or Ilex
No. 3X Shutter
Order 122-0547-00 $200



f/1.9—1:0.5
High Writing Rate
Pi Alphax or Ilex
No. 3X Shutter
Order 122-0549-00 $220

f/1.4—1:1
Precise full-size Image
High Writing Rate
Pi Alphax No. 3 Shutter
Order 122-0608-00 $385



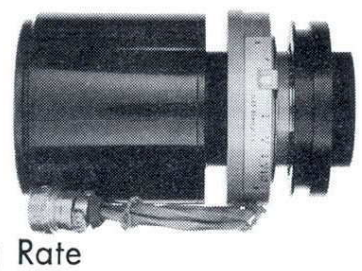
f/1.3—1:0.5
Ultra-High Writing Rate
Ilex No. 3X Shutter
Order 122-0662-00 $360

f/1.9—1:0.85
General Purpose
Pi Alphax or Ilex
No. 3X Shutter
Order 122-0692-00 $180

ELECTRIC SHUTTER/LENS FOR C-12 & C-27 CAMERAS

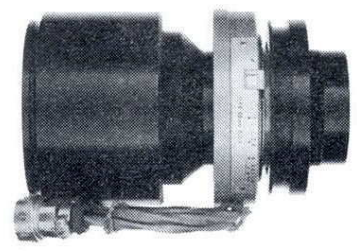
Requires Speedcomputer for operation. Speed Computer is included with all C-12-E and C-27-E Cameras.

f/1.9—1:0.7
Film Economy
Medium Writing Rate
No. 3X Electric Shutter
Order 122-0772-00 $200

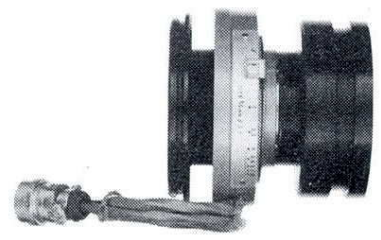


f/1.9—1:0.5
High Writing Rate
No. 3 Electric Shutter
Order 122-0773-00 $220

f/1.4—1:1
Precise full-size image
High Writing Rate
No. 3 Electric Shutter
Order 122-0840-00 $385



f/1.3—1:0.5
Ultra-High Writing Rate
No. 3X Electric Shutter
Order 122-0769-00 $360



f/1.9—1:0.85
General Purpose
No. 3X Electric Shutter
Order 122-0771-00 $180

Speedcomputer
Order 122-0767-00 $230

Bracket for C-12, C-27
Order 122-0713-00 $6.00

Bracket for C-30A, C-31
Order 407-0477-01 $1.10

FILM BACKS FOR C-12 & C-27 CAMERAS

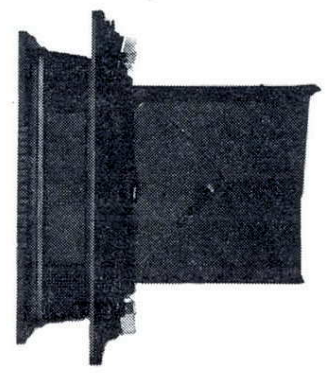
Polaroid Land 3¼ x 4¼
Pack-Film Back, 8 exp
Order 122-0671-00 $83

Focus Plate for above.
Order 387-0893-00 $5

Polaroid Land 3¼ x 4¼
Roll-Film Back, 8 exp
Order 122-0603-00 $83

Focus Plate for above.
Order 387-0460-00 $5

(Focus Plates not needed if Graflok Back is available.)



4 x 5 Graflok Back with Focusing Screen accepts standard cut-film holders, film-pack adapters, roll-film (120) holders, Polaroid 4 x 5 Film Holder.
Order 122-0604-00 $50

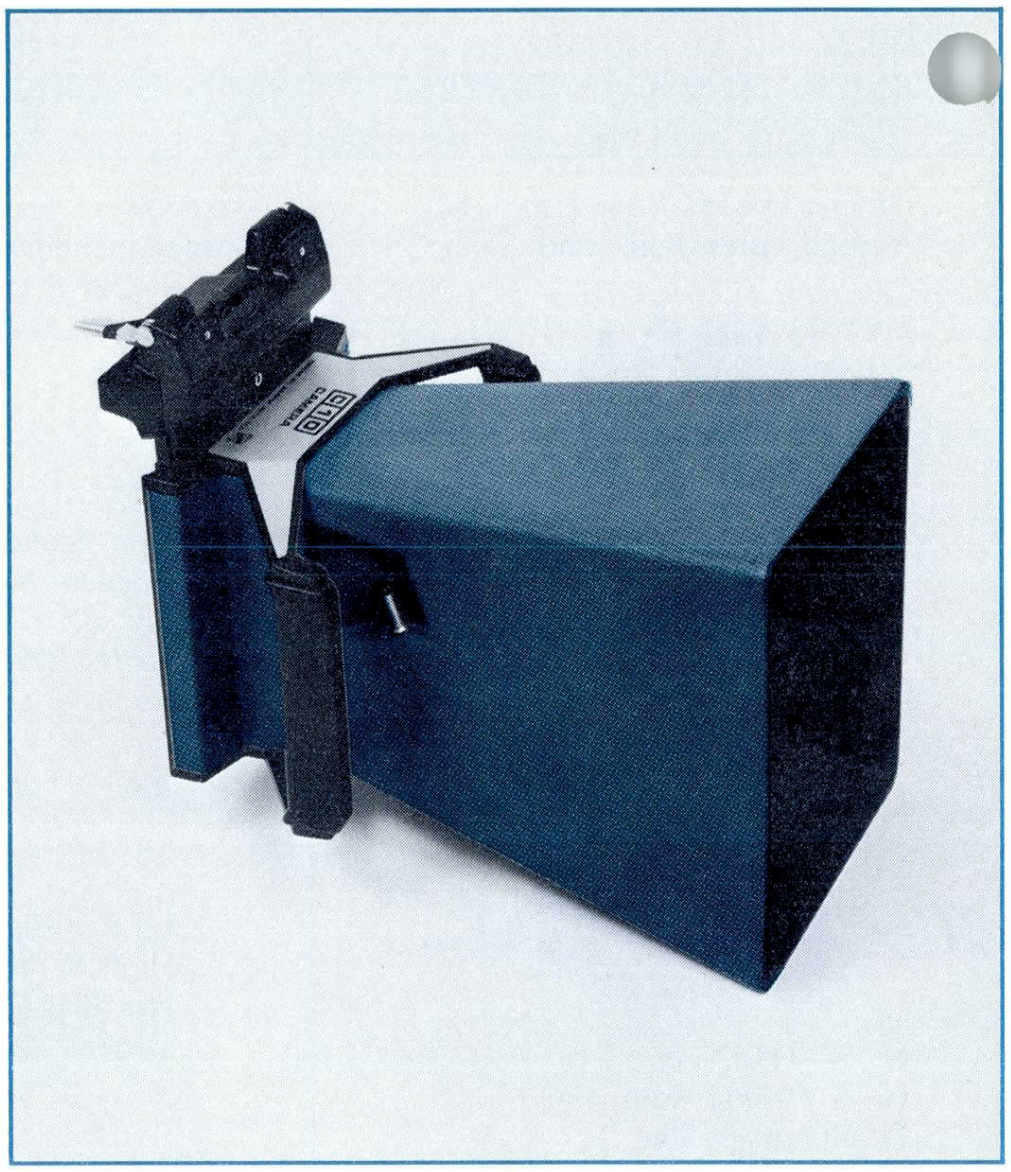
2¼ x 3¼ Graflok Back with Focusing Screen accepts standard cut-film holders, film-pack adapters, roll-film (120) holders.
Order 016-0233-00 $50

ACCESSORIES FOR GRAFLOK BACKS

Additional accessories for Graflok backs are readily available from local camera shops. Accessories available are: 2 or 6-exposure Film Holder, 16-exposure Film-Pack Adapter, 8, 10 or 12-exposure 120 Roll-Film Holder and Polaroid Land 4 x 5 Film Holder.

NEW

C-10 Trace-Recording Camera C-10



- ***LIGHTWEIGHT***
- ***FIXED FOCUS***

The C-10 is a fixed-focus, light-weight, trace-recording camera designed for use with the Tektronix Type 611, 11-inch storage display unit. An f/8 lens with sufficient depth of field, and convenient hand grips allow the C-10 to be held against the oscilloscope CRT without sacrificing picture quality. The camera housing accommodates a Graflok[1] 4 x 5 film back.

LENS
64.40 mm, f/8 trace-recording lens stops down to f/22.

SHUTTER SPEEDS
1, 1/2, 1/4, 1/8, 1/15, 1/30, 1/60 and 1/125 plus Bulb and Time.

RELATIVE APERTURE
f/8, 11, 16, 22.

OBJECT-TO-IMAGE RATIO
1:0.5, records entire 11-inch CRT display on a standard 3¼ x 4¼ Polaroid[2] cut film.

FILM BACK
Graflok back with Polaroid cut-film holder mounted. Cut-film holder accepts 3,000-speed film which develops outside the camera in about 15 seconds.

[1]Registered Trademark Graflex, Inc.
[2]Registered Trademark Polaroid Corporation.

MECHANICAL
Hand held via convenient hand grips on each side. Camera housing of die-cast high-impact plastic.

DIMENSIONS AND WEIGHTS
(Back in Place)

Length	13¾ in	34.9 cm
Width	10⅜ in	26.4 cm
Height	8¾ in	22.3 cm
Net Weight	5.5 lb	2.5 kg

INCLUDED STANDARD ACCESSORIES
Two instruction manuals (070-0988-00)

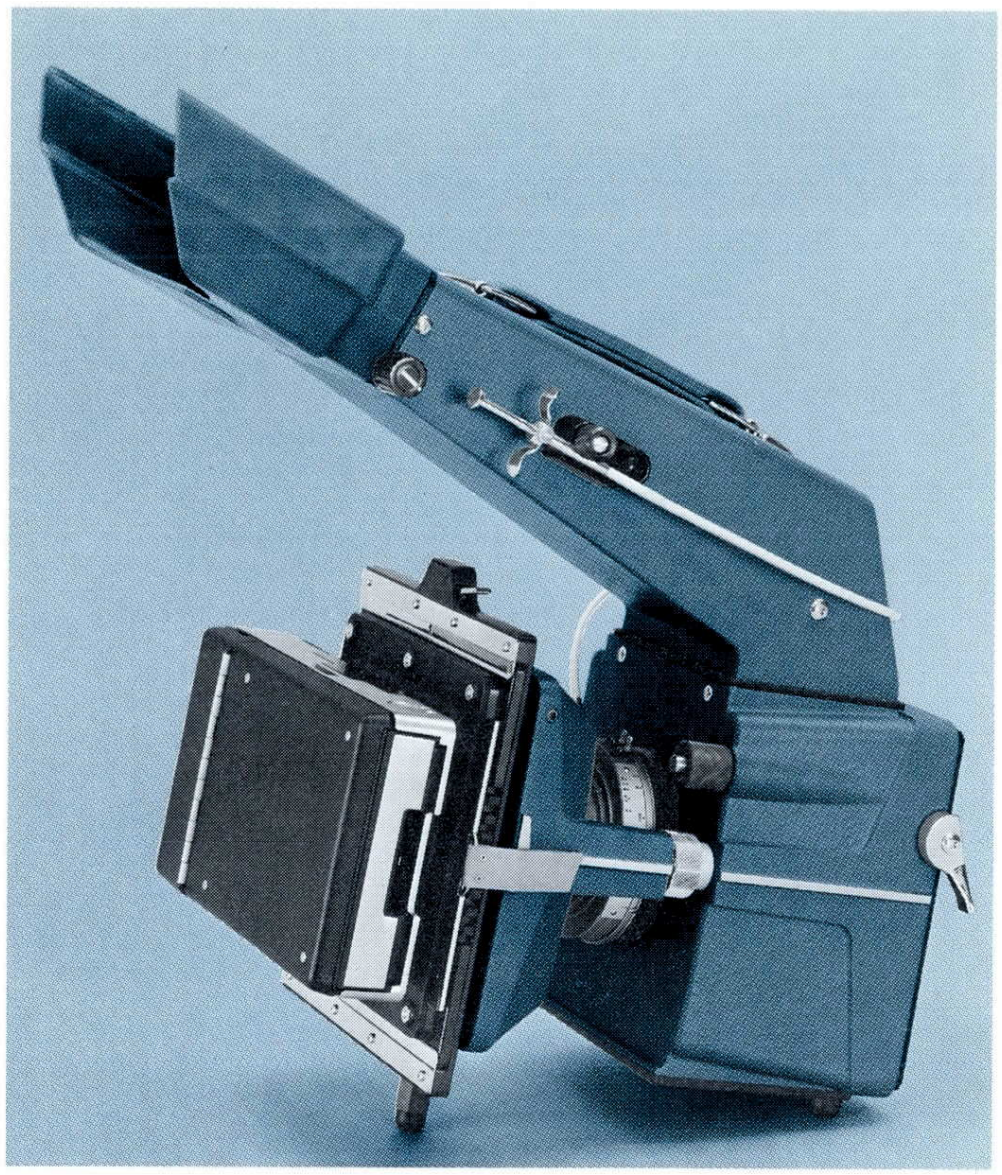
C-10 CAMERA **$400**

U.S. Sales Prices F.O.B Beaverton, Oregon

C-12 Trace-Recording Camera C-12

- ***NO-PARALLAX BINOCULAR VIEWING***
- ***LIFT-ON MOUNTING, SWING-AWAY HINGING***
- ***EASILY-ACCESSIBLE CONTROLS***
- ***ROTATING & SLIDING BACK***
- ***LENS & BACK OPTIONS***
- ***ACCEPTS PROJECTED GRATICULE ACCESSORY***

The C-12 is a general-purpose trace-recording camera suitable for use with most Tektronix full-size oscilloscopes. The special beam-splitting mirror in the C-12 (and another conventional mirror) reflects a portion of the image up through the viewing tunnel, giving the viewer the impression of a straight-on view of the CRT. This no-parallax binocular viewing is especially desirable when the oscilloscope has an external graticule. The beam-splitting mirror also allows use of the Projected Graticule accessory. The beam-splitting mirror transmits approximately 65% of available light to the film.



STANDARD C-12

LENS
75-mm f/1.9 oscilloscope recording lens, stops down to f/16.

SHUTTER SPEEDS
1 to 1/50 second plus Bulb and Time.

OBJECT-TO-IMAGE RATIO
1:0.85, records 8 x 10-cm graticule on 3¼ x 4¼ Polaroid[1] film.

FILM BACK
Polaroid Pack-Film Back accepts 3000-speed film which develops outside camera in about 10 seconds.

MECHANICAL
Lift-on mounting and swing-away hinging with C-12 Camera Adapter (not included). Accepts Projected Graticule.

DIMENSIONS AND WEIGHTS

Height	15⅜ in	39.0 cm
Width	7½ in	19.0 cm
Depth	17¼ in	43.8 cm
Net weight	12¼ lb	5.6 kg
Domestic shipping weight	≈16 lb	≈ 7.3 kg
Export-packed weight	≈33 lb	≈15.0 kg

INCLUDED STANDARD ACCESSORIES
Cable release (122-0586-02), focus plate (387-0893-00), two instruction manuals (070-0383-02).

C-12 CAMERA **$490**

ROLL-FILM CAMERA identical to the Standard C-12, except a Polaroid Roll-Film Back is substituted for the Pack-Film Back.
C-12-R CAMERA **$490**

[1]Registered Trademark Polaroid Corporation.

C-12-E ELECTRIC SHUTTER/CAMERA

An Electric Shutter/Speedcomputer is available for the Type C-12 Camera, permitting remote actuation of the camera. It is intended for use in areas where a large number of cameras need to be remotely controlled or when there is limited access to the oscilloscope and camera at the time of use.

SHUTTER SPEEDS
Time (T), 4, 2, 1, 1/2, 1/4, 1/8, 1/15, 1/30, and 1/60 of a second.

SHUTTER LIGHT
The shutter light indicates that the shutter is open.

REMOTE ACTUATION
Remote actuation is obtained with a single ground closure.

LINE VOLTAGE
115 V AC ±10%, can be wired for 230 V AC ±10%.

C-12-E ELECTRIC SHUTTER CAMERA **$710**

C-12-RE ELECTRIC SHUTTER CAMERA, Roll-Film Back **$710**

All cameras are sold without mounting adapter; see next page.

OPTIONAL ACCESSORIES

PROJECTED GRATICULE for 115 volts, order 016-0204-00 $175

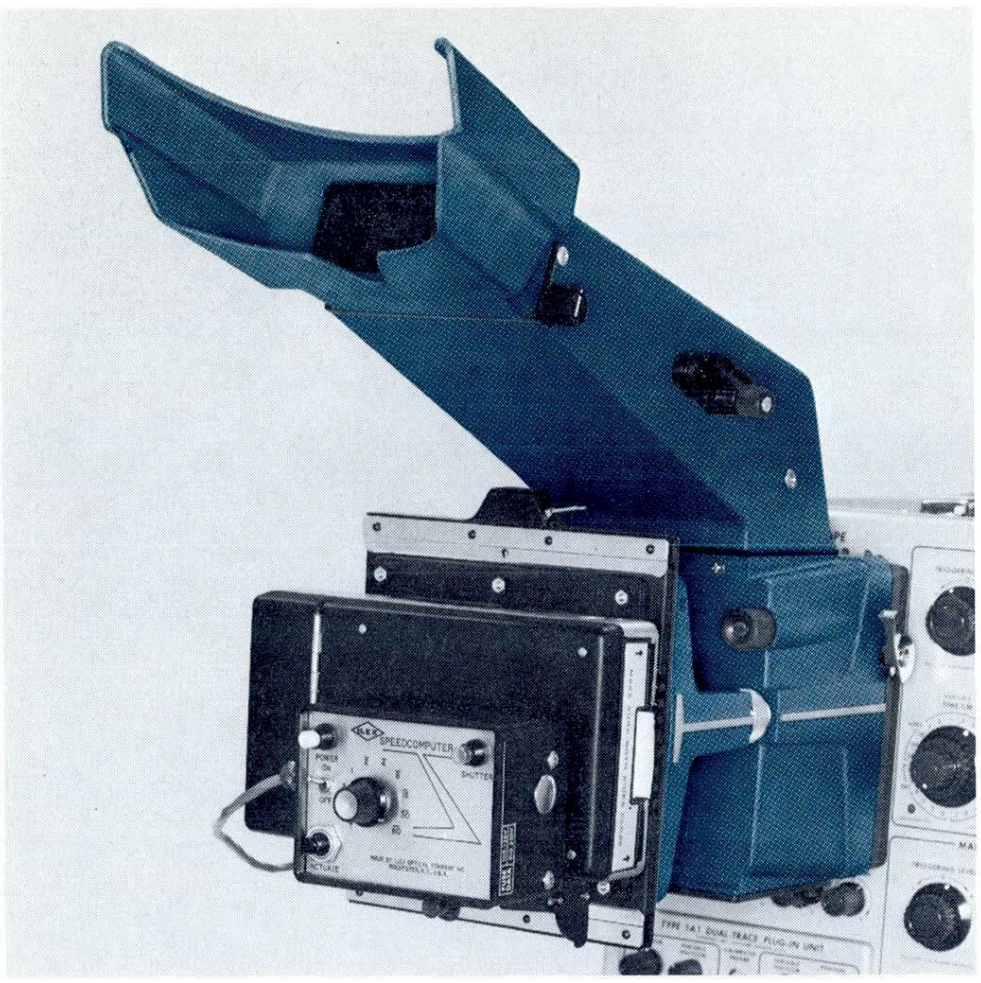
PROJECTED GRATICULE for 230 volts, order 016-0234-00 $175

CARRYING CASE, order 016-0208-01 ..... $ 85

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Trace-Recording Camera

C-12



ELECTRIC SHUTTER/SPEEDCOMPUTER

SWING-AWAY HINGING

CUSTOM C-12 CAMERAS				
LENS (Writing speed compared to Standard f/1.9, 1:0.85 lens)	ELECTRIC SHUTTER/ SPEEDCOMPUTER	POLAROID FILM BACK	ORDER NUMBER	PRICE
FILM ECONOMY & MEDIUM WRITING SPEED—f/1.9, 1:0.7. Records two 6 x 10-cm or three 4 x 10-cm graticules on each film. Writing speed 1.25X Standard Lens.	No	Pack Film Roll Film	C-12-547 C-12-547 R	$510 $510
	Yes	Pack Film Roll Film	C-12-547 E C-12-547 RE	$730 $730
HIGH WRITING SPEED—f/1.9, 1:0.5 Records fast-writing displays such as single-shot transients. Writing speed 1.5X Standard Lens.	No	Pack Film Roll Film	C-12-549 C-12-549 R	$535 $535
	Yes	Pack Film Roll Film	C-12-549 E C-12-549 RE	$750 $750
PRECISE FULL-SIZE IMAGE & HIGH WRITING SPEED—f/1.4, 1:1. Records full-size image of 8 x 10-cm graticule (on 4 x 5 film with optional Graflok[2] Back). Writing speed 1.75X Standard Lens.	No	Pack Film Roll Film	C-12-608 C-12-608 R	$690 $690
	Yes	Pack Film Roll Film	C-12-608 E C-12-608 RE	$910 $910
ULTRA-HIGH WRITING SPEED—f/1.3, 1:0.5 Where writing speed is prime consideration. Records two 6 x 10-cm graticules on each film. Writing speed 3X Standard Lens.	No	Pack Film Roll Film	C-12-662 C-12-662 R	$665 $665
	Yes	Pack Film Roll Film	C-12-662 E C-12-662 RE	$885 $885

Any C-12 Standard or Custom Trace-Recording Camera can be ordered less back. Use suffix "G" after the Order Number and deduct $80 from the price. 4 x 5 or 2¼ x 3¼ Graflok Backs are shown in the component pages. Additional accessories for Graflok backs are readily available from local camera shops. Accessories available are: 2 or 6-exposure Film Holder, 16-exposure Film-Pack Adapter, 8, 10 or 12-exposure 120 Roll-Film Holder and Polaroid Land 4 x 5 Film Holder.

C-12 cameras are sold without mounting adapter. Order 016-0226-01 for Tektronix Oscilloscopes with 5-inch round CRT (except Type 519 and 520). Order 016-0217-00 for Tektronix Oscilloscopes with 5-inch rectangular CRT (except Type 528, 601, 602 and 647). Adapters are available for some non-Tektronix Oscilloscopes. Price is $16 each.

[2]Registered Trademark Graflex, Inc.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Projected Graticule for C-12

The Projected Graticule for the C-12 Camera eliminates parallax and provides an area that can be used for write-in data.

Parallax is the apparent displacement of the trace in relation to the graticule. Error is introduced since the graticule and CRT phosphor are on different planes.

To eliminate parallax, a virtual image of the graticule is presented at the CRT phosphor plane, as viewed by the operator and as projected to the camera film plane.

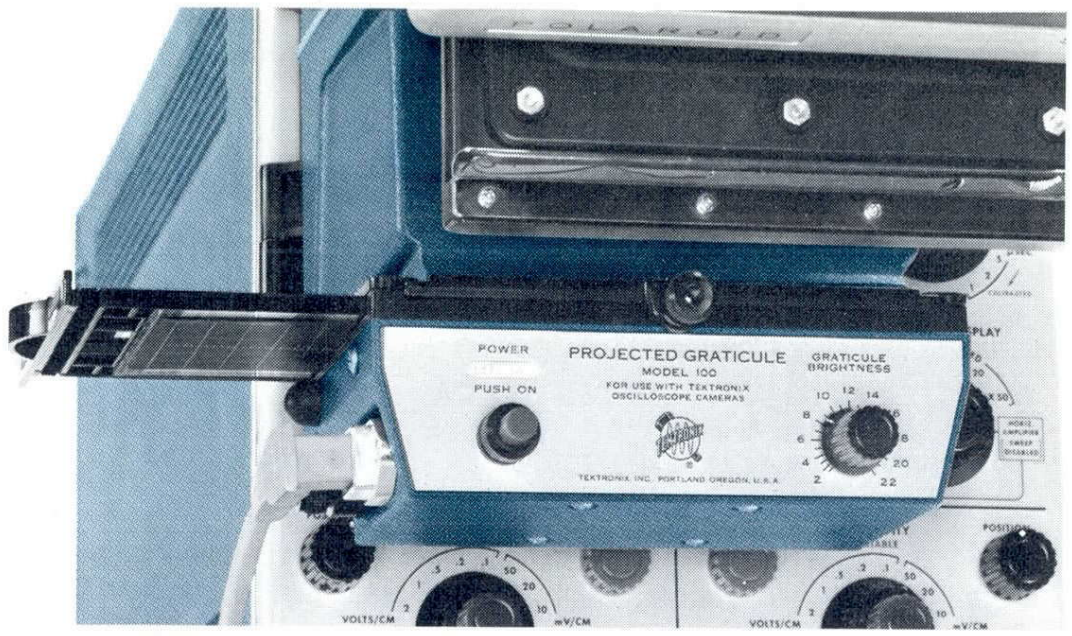
Special graticules, reference waveforms, or any image that can be recorded on a film transparency, can be superimposed on the CRT display. The graticule is held in a slide assembly and is easily slipped in and out of the Projected Graticule case, making possible rapid change of graticules. The included slide assembly has a clear window. Assemblies can be obtained (see below) in several colors to match or contrast the projection with the CRT phosphor.

The projected graticule provides up to an 8 x 10-cm projection, a portion of which can be used for write-in data.

The light source is indexed in approx ½-f stop increments for use as a film exposure guide. This source can also be used for precise prefogging of film for increased sensitivity in fast writing-speed applications.

Operates on 90 to 130 V, or 180 to 260 V, 50 to 440 Hz.

Although the Projected Graticule case is small (it adds only 2¼ inches to camera height), clearance problems exist with the Type 81A Adapter and a few plug-in unit/probe combinations. **If in doubt about compatibility, please consult your Tektronix Field Office, Representative or Distributor.**



PROJECTED GRATICULE for 115 volts (016-0204-00) . . **$175**

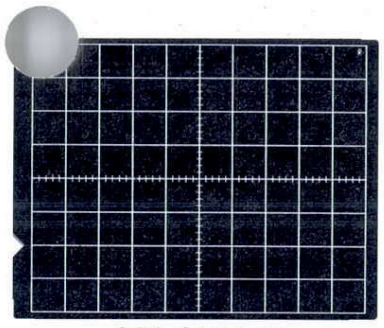
PROJECTED GRATICULE for 230 volts (016-0234-00) . . **$175**

Includes: 1—power cord (161-0015-01); 1—3 to 2-wire adapter (103-0013-00); 1—graticule, 4 x 10 cm with write-in area and short minor lines (331-0117-00); 1—graticule, 6 x 10 cm with write-in area and short minor lines (331-0111-00); 1—graticule, 8 x 10 cm without write-in area, but with full minor lines (331-0119-00); 1—graticule mask, 4 x 10 cm (331-0118-00); 1—graticule mask, 6 x 10 cm (331-0116-00).

GRATICULE SLIDE ASSEMBLIES . . . . . $3 each

Clear Window 122-0659-00	Green Window 122-0668-00
Blue Window 122-0667-00	Amber Window 122-0669-00

OPTIONAL GRATICULES and MASKS . . . . . $1.40 each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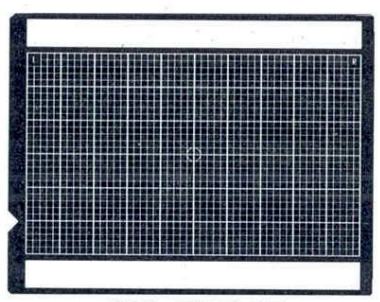
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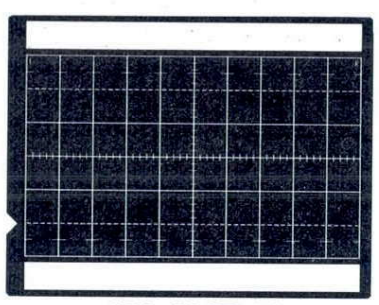
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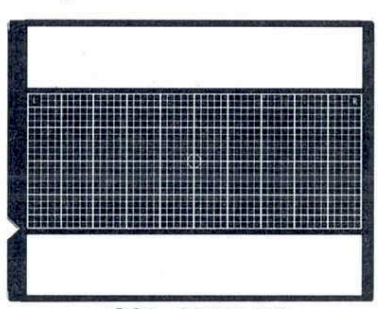
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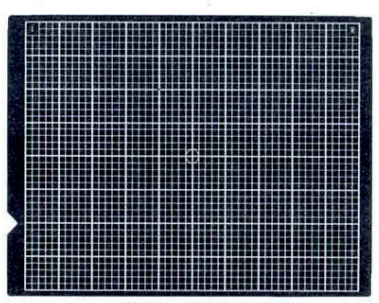
6 x 10 cm Mask 331-0116-00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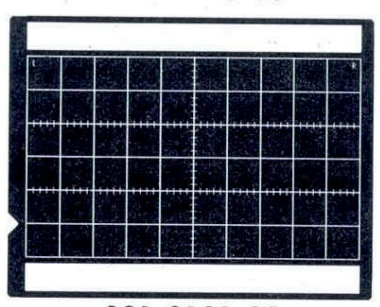
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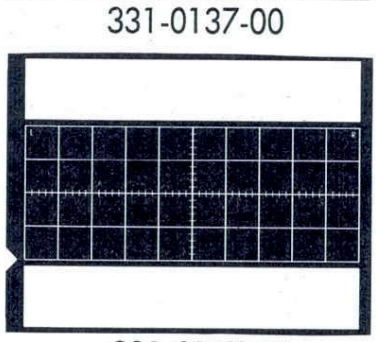
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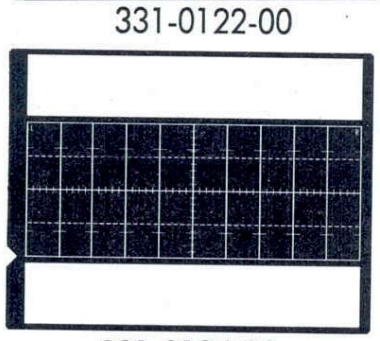
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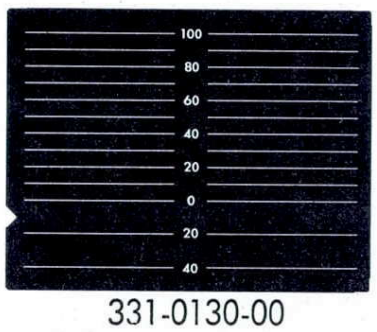
4 x 10 cm Mask 331-0118-00



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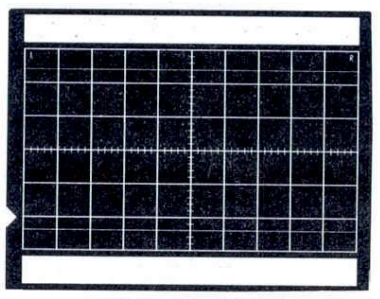
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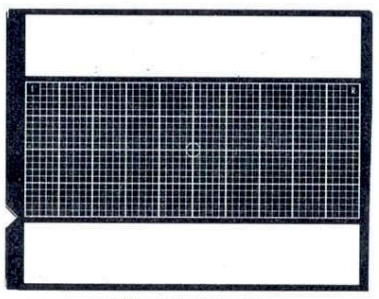
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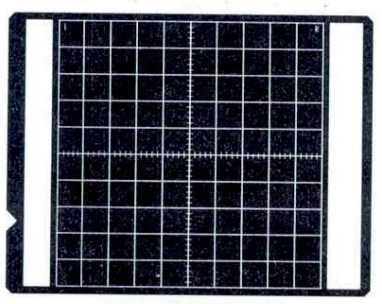
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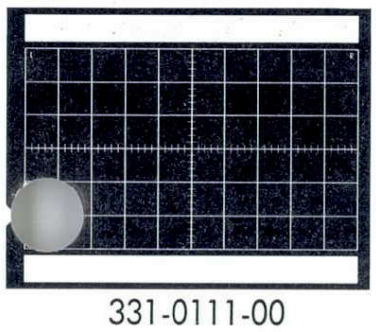
10 x 10 div Mask (for Type 570, 575, 536) 331-0129-00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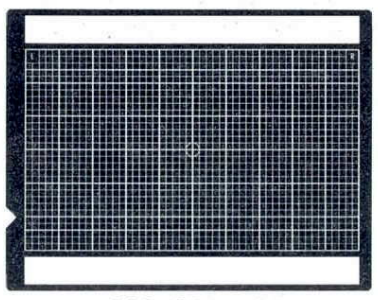
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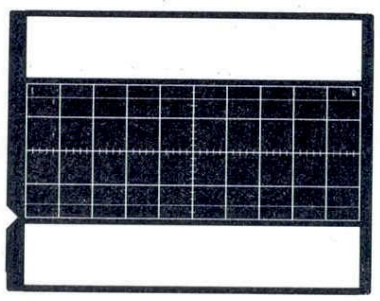
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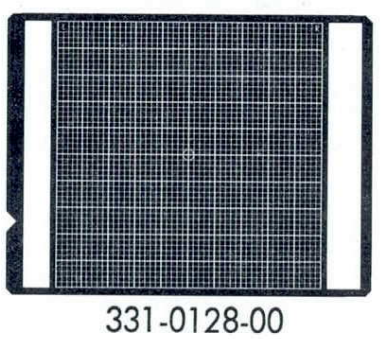
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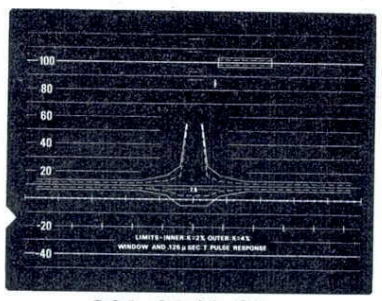

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U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Trace-Recording Camera

C-27

- ***COMFORTABLE BINOCULAR VIEWING***
- ***LIFT-ON MOUNTING, SWING-AWAY HINGING***
- ***EASILY-ACCESSIBLE CONTROLS***
- ***ROTATING & SLIDING BACK***
- ***LENS & BACK OPTIONS***

The C-27 is a general-purpose trace-recording camera suitable for use with most Tektronix full-size oscilloscopes. The viewer sees the CRT without the use of mirrors. As a result the maximum amount of light is transferred to the film. The viewing tunnel can be easily removed, and the carrying handle folded out of the way. This allows camera mounting on two 7-inch rack-model oscilloscopes placed one over the other. In addition the camera frame can be rotated 90° or 180°, thus positioning the viewing tunnel at either side or at the bottom of the camera. The opening at the camera front allows the complete photographic coverage of large graticules such as the Type 502A Oscilloscope.

STANDARD C-27

LENS
75-mm f/1.9 oscilloscope recording lens, stops down to f/16.

SHUTTER SPEEDS
1 to 1/50 second plus Bulb and Time.

OBJECT-TO-IMAGE RATIO
1:0.85, records 8 x 10-cm graticule on 3¼ x 4¼ Polaroid[1] film, 10 x 10-cm graticule with optional Graflok[2] Back and 4 x 5 film.

FILM BACK
Polaroid Pack-Film Back accepts 3000-speed film which develops outside camera in about 10 seconds.

MECHANICAL
Lift-on mounting and swing-away hinging with C-27 Camera Adapter (not included).

DIMENSIONS AND WEIGHTS

Height with viewing tunnel	17 3/16 in	43.7 cm
Height without viewing tunnel	8 in	20.3 cm
Width	7½ in	19.0 cm
Depth with viewing tunnel	13⅜ in	33.9 cm
Depth without viewing tunnel	12 in	30.5 cm
Net weight	10½ lb	4.8 kg
Domestic shipping weight	≈14 lb	≈ 6.4 kg
Export-packed weight	≈36 lb	≈16.4 kg

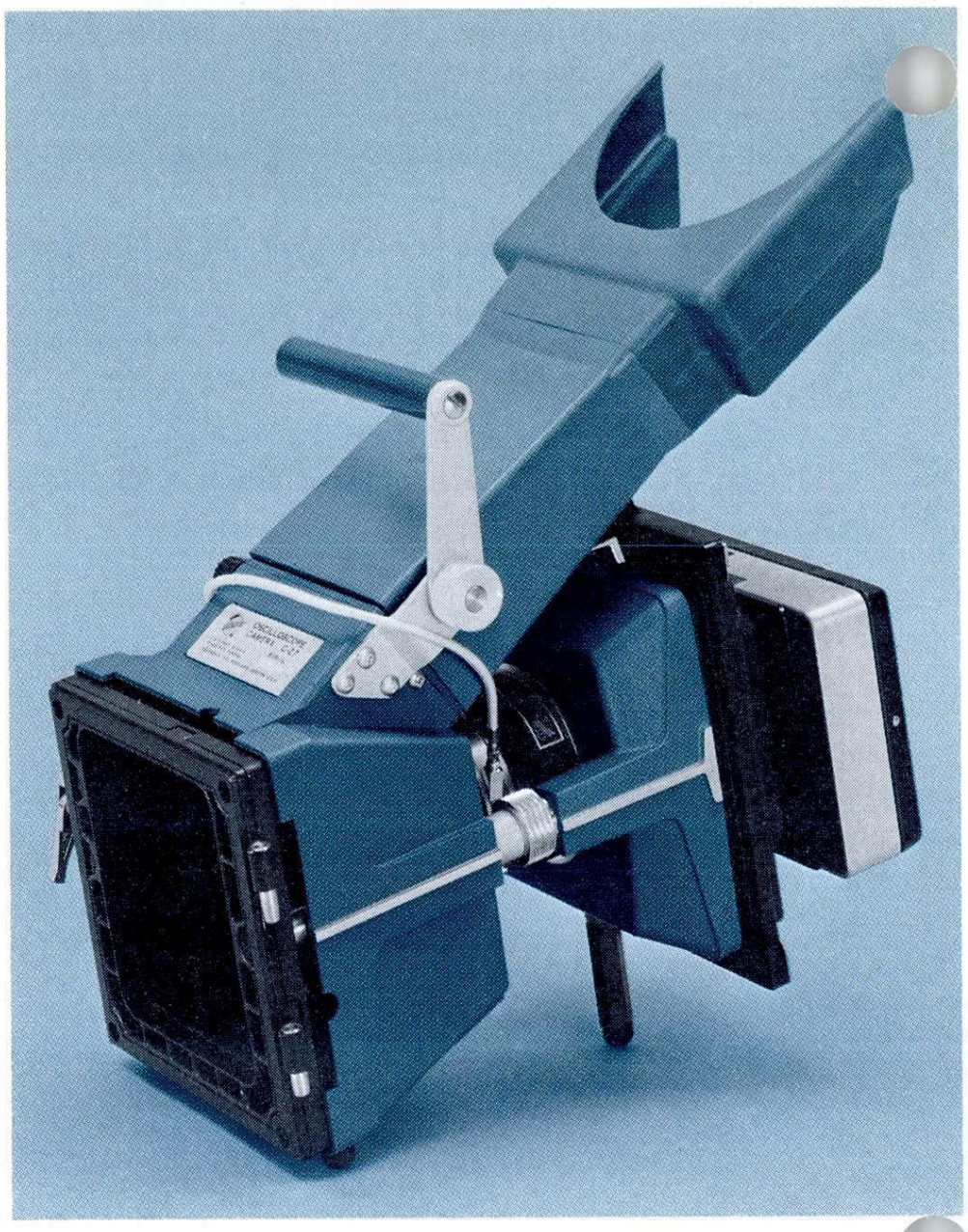
INCLUDED STANDARD ACCESSORIES
Cable release (122-0586-02), focus plate (387-0893-00), two instruction manuals (070-0383-02).

C-27 CAMERA **$460**

ROLL-FILM CAMERA identical to the Standard C-27, except a Polaroid Roll-Film Back is substituted for the Pack-Film Back.

C-27-R CAMERA **$460**

[1]Registered Trademark Polaroid Corporation.
[2]Registered Trademark Graflex, Inc.



C-27-E ELECTRIC SHUTTER CAMERA

An Electric Shutter/Speedcomputer is available for the Type C-27 Camera, permitting remote actuation of the camera. It is intended for use in areas where a large number of cameras need to be remotely controlled or when there is limited access to the oscilloscope and camera at the time of use.

SHUTTER SPEEDS
Time (T), 4, 2, 1, 1/2, 1/4, 1/8, 1/15, 1/30, and 1/60 of a second.

SHUTTER LIGHT
The shutter light indicates that the shutter is open.

REMOTE ACTUATION
Remote actuation is obtained with a single ground closure.

LINE VOLTAGE
115 V AC ±10% or 230 V AC ±10%.

C-27-E ELECTRIC SHUTTER CAMERA **$680**

C-27-RE ELECTRIC SHUTTER CAMERA, Roll-Film Back **$680**

OPTIONAL ACCESSORY

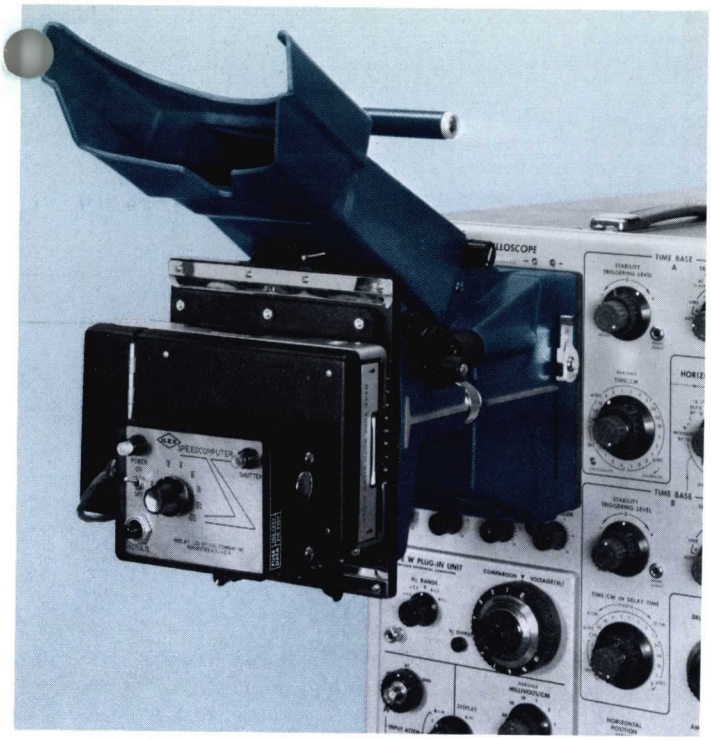
CARRYING CASE, order 016-0208-01 ..... $85

All C-27 cameras are sold without mounting adapter; see next page.

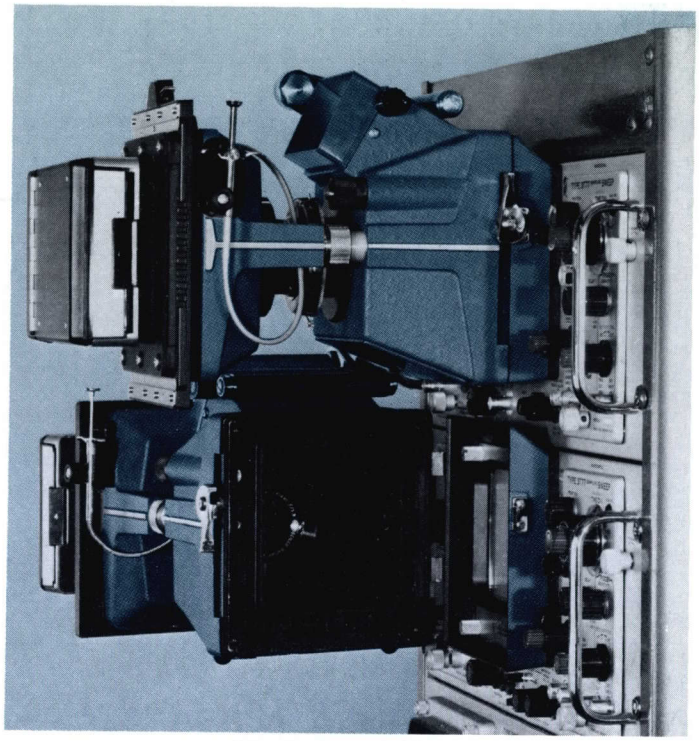
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Trace-Recording Camera

C-27



ELECTRIC SHUTTER/SPEEDCOMPUTER



COMPACT STACKING

CUSTOM C-27 CAMERAS				
LENS (Writing speed compared to Standard f/1.9, 1:0.85 lens)	ELECTRIC SHUTTER/ SPEEDCOMPUTER	POLAROID FILM BACK	ORDER NUMBER	PRICE
FILM ECONOMY & MEDIUM WRITING SPEED—f/1.9, 1:0.7. Records two 6 x 10-cm, three 4 x 10-cm or one 10 x 10-cm graticule on 3¼ x 4¼ film. Writing speed 1.25X Standard Lens.	No	Pack Film Roll Film	C-27-547 C-27-547 R	$480 $480
	Yes	Pack Film Roll Film	C-27-547 E C-27-547 RE	$700 $700
HIGH WRITING SPEED—f/1.9, 1:0.5 Records fast-writing displays such as single-shot transients. Writing speed 1.5X Standard Lens.	No	Pack Film Roll Film	C-27-549 C-27-549 R	$505 $505
	Yes	Pack Film Roll Film	C-27-549 E C-27-549 RE	$720 $720
PRECISE FULL-SIZE IMAGE & HIGH WRITING SPEED—f/1.4, 1:1. Records full-size image of 10 x 10-cm graticule (on 4 x 5 film with optional Graflok Back). Writing speed 1.75X Standard Lens.	No	Pack Film Roll Film	C-27-608 C-27-608 R	$665 $665
	Yes	Pack Film Roll Film	C-27-608 E C-27-608 RE	$885 $885
ULTRA-HIGH WRITING SPEED—f/1.3, 1:0.5 Records two 6 x 10-cm graticules on each film. Writing speed 3X Standard Lens.	No	Pack Film Roll Film	C-27-662 C-27-662 R	$635 $635
	Yes	Pack Film Roll Film	C-27-662 E C-27-662 RE	$855 $855

Any C-27 Standard or Custom Trace-Recording Camera can be ordered less back. Use suffix "G" after the Order Number and deduct $80 from the price. 4 x 5 or 2¼ x 3¼ Graflok Backs are shown in the component pages. Additional accessories for Graflok Backs are readily available from local camera shops. Accessories available are: 2 or 6-exposure Film Holder, 16-exposure Film-Pack Adapter, 8, 10 or 12-exposure 120 Roll-Film Holder and Polaroid Land 4 x 5 Film Holder.

All C-27 cameras are sold without mounting adapter. Order 016-0225-02 for Tektronix Oscilloscopes with 5-inch round CRT (except Type 519). Order 016-0224-00 for Tektronix Oscilloscopes with 5-inch rectangular CRT (except 528, 601, 602, and 647). Order 016-0249-01 for Type 528, 601, and 602. Order 016-0223-00 for Type 647. Adapters are available for some non-Tektronix Oscilloscopes. Price is $16 each.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

C-30A Trace-Recording Camera C-30A

- ***VARIABLE MAGNIFICATION***
- ***COMPACT, LIGHT WEIGHT***
- ***EASILY-ACCESSIBLE CONTROLS***
- ***OPTIONAL FILM BACKS***

The C-30A is a compact, light weight trace-recording camera designed for use with Tektronix portable instruments. It mounts directly to Type 422, 453, and 454 Oscilloscopes and Type 491 Spectrum Analyzer. Camera adapters are available for other portable and full-size oscilloscopes. The camera swings open from the left or right, as desired, and can be quickly lifted off the oscilloscope when not needed.

The C-30A uses a f/1.9 lens and features an adjustable magnification from 1:1.5 to 1:0.7. Optional film backs can be rapidly interchanged without refocusing the camera. Dark slides are included with all the film backs to permit changing backs without exposing any film.

LENS
56-mm f/1.9 oscilloscope recording lens, stops down to f/16.

SHUTTER SPEEDS
1 to 1/50 second plus Bulb and Time.

MAGNIFICATION
Variable in indexed steps of 1.5, 1.4, 1.3, 1.2, 1.1, 1.0, 0.9, 0.85, 0.8 and 0.7. At 0.7 magnification, an 8 x 10-cm or 10 x 10-div graticule can be recorded in its entirety.

FILM BACK
Polaroid[1] Pack-Film back accepts 3000-speed film which develops outside camera in about 10 seconds.

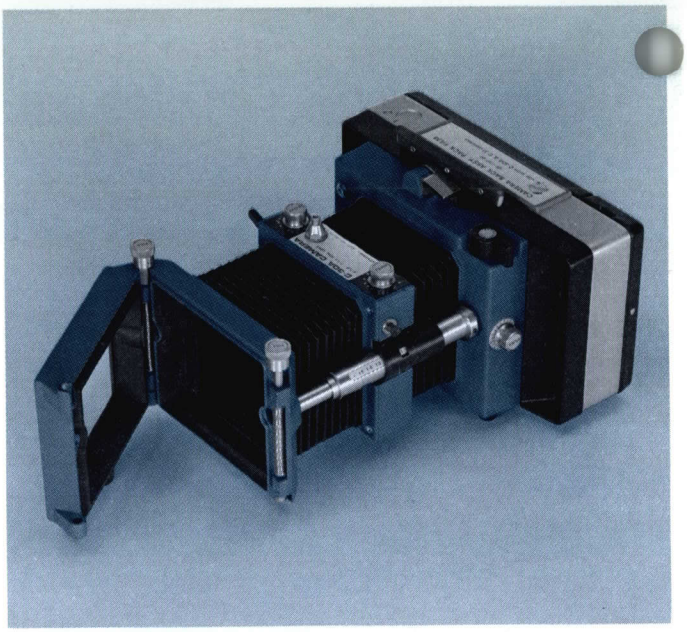
MECHANICAL
Lift-on mounting and swing-away hinging from left or right side. Mounts directly to Type 422, 453 and 454 Oscilloscopes and Type 491 Spectrum Analyzer. Optional camera adapters allow use with other Tektronix Oscilloscopes.

DIMENSIONS AND WEIGHTS

Height	5½ in	14 cm
Width	7 9/16 in	19.2 cm
Depth	10 in	25.4 cm
Net weight	4¾ lb	2.2 kg
Domestic shipping weight	≈ 9 lb	≈ 4.1 kg
Export-packed weight	≈14 lb	≈ 6.4 kg

INCLUDED STANDARD ACCESSORIES
Light seal for Type 422 and 491 (354-0279-00); light seal for Type 453 and 454 (354-0280-00); focus plate (387-0893-00); two instruction manuals (070-0808-01).

C-30A-P CAMERA, Pack-Film Back **$480**



C-30A-R ROLL-FILM CAMERA is identical to the standard C-30A-P, except a Polaroid Roll-Film Back is substituted for the Pack-Film Back and the focus plate is changed to (387-0460-00).

C-30A-R CAMERA, Roll-Film Back **$480**

C-30A-G GRAFLOK[2] BACK CAMERA is identical to the standard C-30A-P, except a 2¼ x 3¼ Graflok Back is substituted for the Roll-Film Back and the focus plate is removed from the standard accessories. The Graflok Back has a built-in focus screen and accepts standard cut-film holders, film-pack adapters and roll-film (120) holders.

C-30A-G CAMERA, Graflok Back **$445**

OPTIONAL LENS

A portra lens will enable the Type C-30A Camera to photograph test setups. The depth of field when using the portra lens will vary with the f stop and magnification settings used. Generally, at f/1.9 there will be very little depth of field; while at f/16, the depth of field will allow quite a wide range of distance to be accommodated, depending upon the picture sharpness required. At a distance of 21 inches, a subject area 22 inches in diameter can be covered. Lens stores inside C-30A when not used; hardware included.

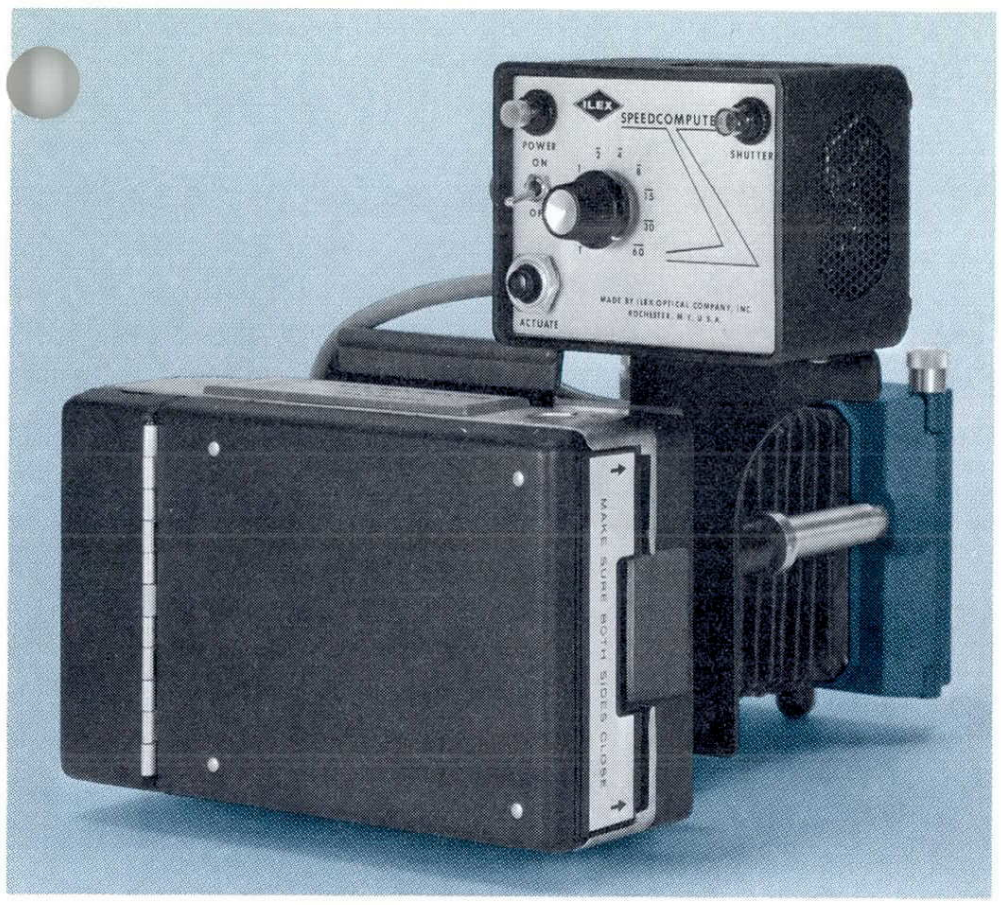
Order 016-0246-00 ..... $11

[1]Registered Trademark Polaroid Corporation

[2]Registered Trademark Graflex, Inc.

Trace-Recording Camera

C-30A



C-30A ELECTRIC SHUTTER CAMERA

An Electric Shutter/Speedcomputer is available for the Type C-30A Camera, permitting remote actuation of the camera. It is intended for use in areas where a large number of cameras need to be remotely controlled or when there is limited access to the oscilloscope and camera at the time of use.

SHUTTER SPEEDS

Bulb (B), Time (T), 4, 2, 1, 1/2, 1/4, 1/8, 1/15, 1/30, and 1/60 of a second.

SHUTTER LIGHT

The shutter light indicates that the shutter is open.

REMOTE ACTUATION

Remote actuation is obtained with a single ground closure.

LINE VOLTAGE

115 V AC ±10% or 230 V AC ±10%.

C-30A-PE ELECTRIC SHUTTER CAMERA, Pack-Film Back **$705**

C-30A-RE ELECTRIC SHUTTER CAMERA, Roll-Film Back **$705**

C-30A-GE ELECTRIC SHUTTER CAMERA, Graflok Back **$670**

CARRYING CASE

The carrying case holds the C-30A or C-31 Camera and all standard accessories including up to three Film Backs, extra bezels and extra film. The case is constructed of heavy-gage, high-impact plastic and has a vacuum-formed styrene liner. Dimensions are $7\frac{3}{16} \times 13\frac{3}{16} \times 15\frac{3}{16}$ inches.

Order 016-0126-00 . . . . . $38

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

CAMERA ADAPTERS

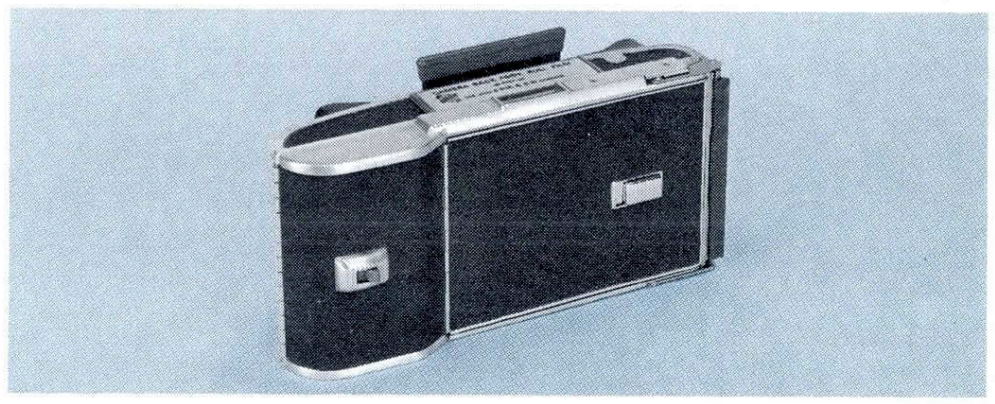
($16 each)

FOR OSCILLOSCOPE TYPE	PART NUMBER
310A, 317, 360	016-0241-00
321A	016-0242-00
Tektronix Oscilloscopes with 5-inch round CRT (except Type 519).	016-0243-00
Tektronix 560-Series with rectangular CRT, 529 and RM529.	016-0244-00
528, 601, 602, 7000-Series	016-0248-00

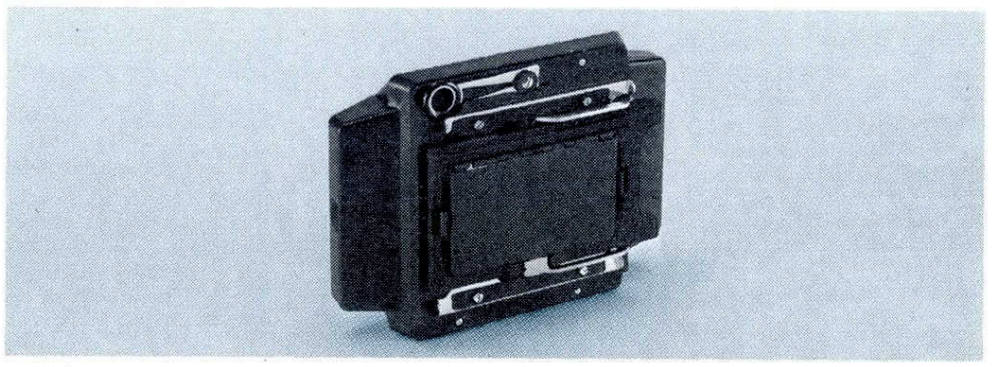
FILM BACKS

Three Film Backs provide flexibility of performance and films. Dark slides are included with all the film backs to permit changing backs without exposing any film.

Pack-Film Back, Polaroid Land Film, $3\frac{1}{4} \times 4\frac{1}{4}$, 8 exposure, order 122-0752-00 . . . . . $83
Focus Plate for above, order 387-0893-00 . . . . . $ 5



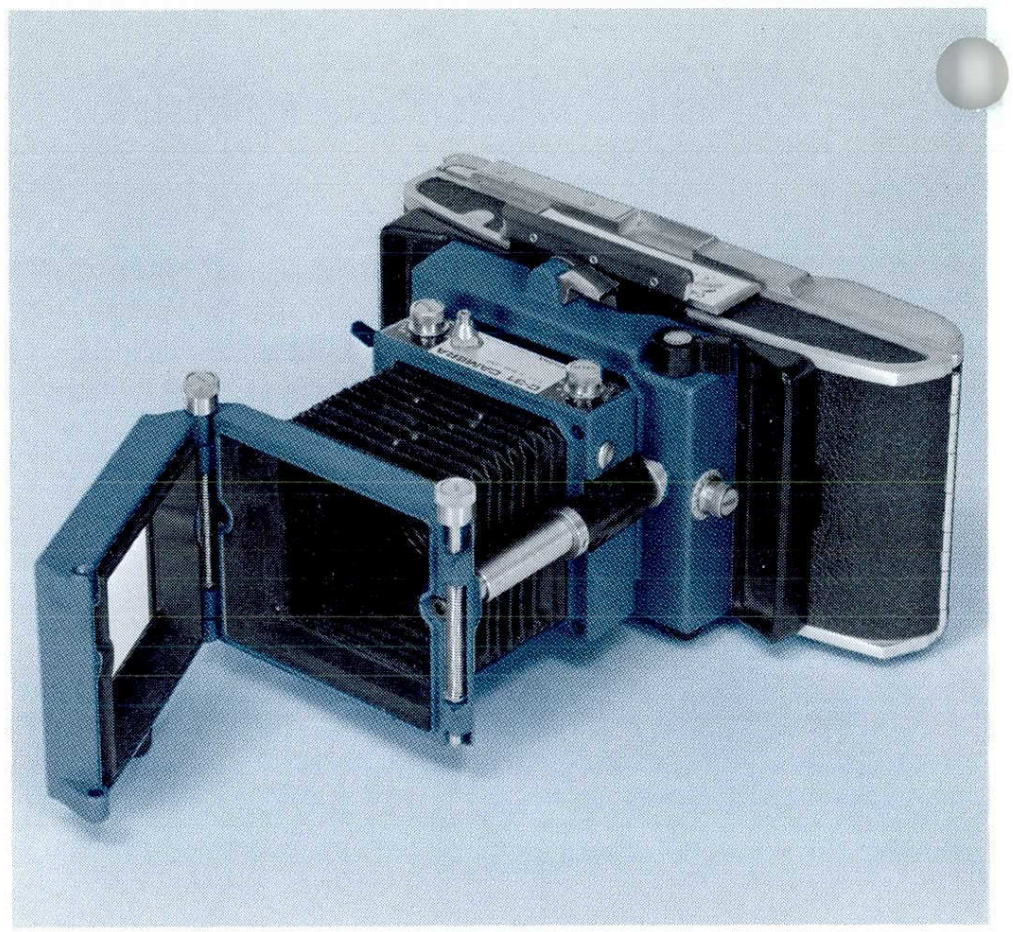
Roll-Film Back, Polaroid Land Film, $3\frac{1}{4} \times 4\frac{1}{4}$, 8 exposure, order 122-0754-00 . . . . . $83
Focus Plate for above, order 387-0460-00 . . . . . $ 5



Graflok Back, $2\frac{1}{4} \times 3\frac{1}{4}$ with focusing screen. Accepts standard cut-film holders, film-pack adapters, roll-film (120) holders, order 122-0755-00 . . . . . $50

C-31 Trace-Recording Camera C-31

- ***HIGH WRITING SPEED***
- ***COMPACT, LIGHT WEIGHT***
- ***EASILY-ACCESSIBLE CONTROLS***
- ***OPTIONAL FILM BACKS***



The C-31 is a compact, high-performance camera designed for Tektronix portable oscilloscopes. It provides the high-writing speed required when Type 453 and 454 Oscilloscopes are operated single-shot at the fastest sweep rates. The C-31 mounts directly to these oscilloscopes, and also to the Type 422 and 491. Camera adapters are available for other portable and full-size oscilloscopes. The camera swings open from the left or right, as desired, and can be quickly lifted off the oscilloscope when not needed.

The C-31 uses an f/1.2—1:0.5 lens and Polaroid[1] 10,000-speed roll film. This combination provides the fastest writing speed available in a Tektronix Standard Camera.

LENS
56-mm f/1.2 oscilloscope recording lens, stops down to f/16.

SHUTTER SPEEDS
1 to 1/60 second plus Bulb and Time.

OBJECT-TO-IMAGE RATIO
1:0.5 records 6 x 10-div graticule (Type 453 and 454) or 8 x 10-div graticules (Type 422 and 491) on $3\frac{1}{4}$ x $4\frac{1}{4}$ Polaroid film.

FILM BACK
Polaroid Roll-Film Back accepts 10,000-speed and 3,000-speed roll film which develops inside the camera in about 10 seconds.

MECHANICAL
Lift-on mounting and swing-away hinging from left or right side. Mounts directly to Type 422, 453 and 454 Oscilloscopes and Type 491 Spectrum Analyzer. Optional camera adapters allow use with other Tektronix Oscilloscopes.

DIMENSIONS AND WEIGHTS

Height	$5\frac{9}{16}$ in	14.1 cm
Width	$9\frac{1}{8}$ in	23.1 cm
Depth	$10\frac{5}{8}$ in	27.0 cm
Net weight	$6\frac{3}{4}$ lb	3.1 kg

INCLUDED STANDARD ACCESSORIES
Light seal for Type 422 and 491 (354-0279-00); light seal for Type 453 and 454 (354-0280-00); focus plate (387-0460-00); two instruction manuals (070-0783-01).

C-31-R CAMERA, Roll-Film Back **$585**

C-31-P PACK-FILM CAMERA is identical to the standard C-31-R, except a Polaroid Pack-Film Back is substituted for the Roll-Film Back and the focus plate is changed to (387-0893-00). Polaroid 10,000 ASA speed film is not available in Film Packs.

C-31-P CAMERA, Pack-Film Back **$585**

C-31-G GRAFLOK[2] BACK CAMERA is identical to the standard C-31-R, except a $2\frac{1}{4}$ x $3\frac{1}{4}$ Graflok Back is substituted for the Roll-Film Back and the focus plate is removed from the Standard Accessories. The Graflok Back has a built-in focusing screen and accepts standard cut-film holders, film-pack adapters, and roll-film (120) holders.

C-31-G CAMERA, Graflock Back **$550**

PHOTOGRAPHIC WRITING SPEED
C-31-R with Type 454 Oscilloscope
(without Film Fogging Techniques)

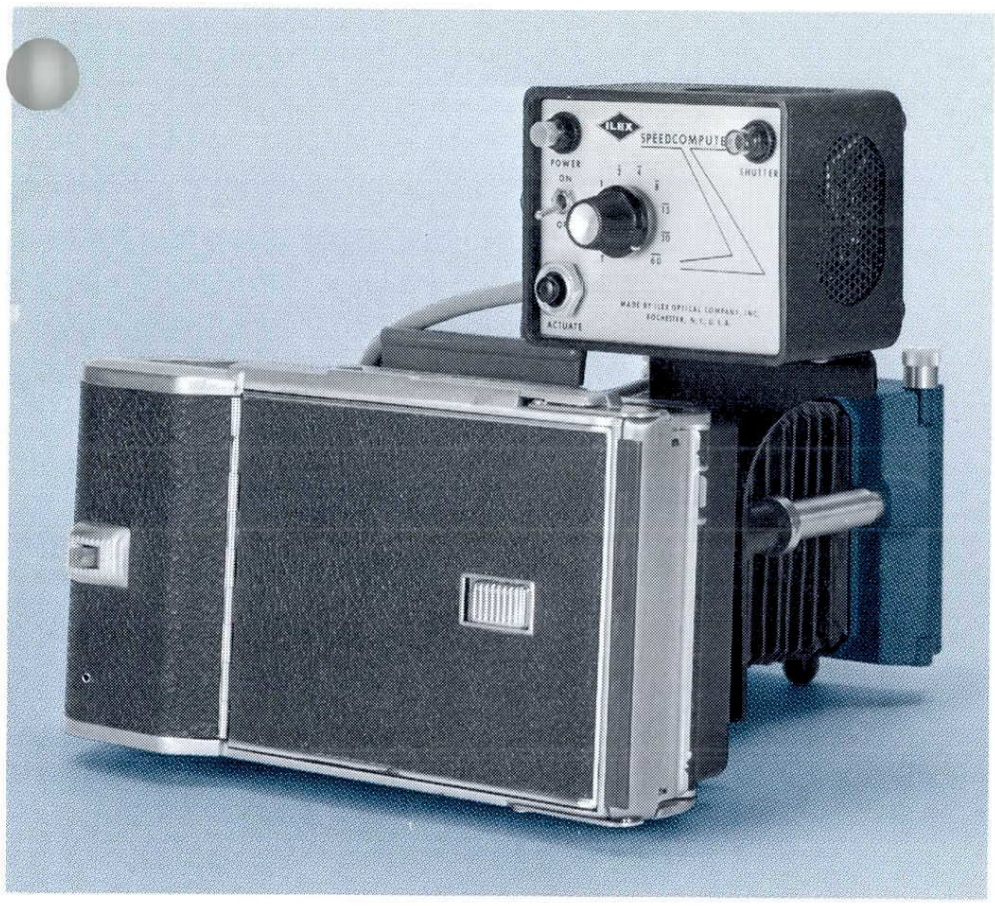
Camera and Phosphor					Minimum Photographic Writing Speed
Camera	Lens	Object-to-image ratio	Polaroid film type	CRT Phosphor	
C-31-R	f/1.2	1:0.5	410 (10,000 ASA)	P31	1600 div/μs (1280 cm/μs)
				P11	3200 div/μs (2560 cm/μs)

[1]Registered Trademark Polaroid Corporation

[2]Registered Trademark Graflex, Inc.

Trace-Recording Camera

C-31



C-31 ELECTRIC SHUTTER CAMERA

An Electric Shutter/Speedcomputer is available for the Type C-31 Camera, permitting remote actuation of the camera. It is intended for use in areas where a large number of cameras need to be remotely controlled or when there is limited access to the oscilloscope and camera at the time of use.

SHUTTER SPEEDS

Bulb (B), Time (T), 4, 2, 1, 1/2, 1/4, 1/8, 1/15, 1/30, and 1/60 of a second.

SHUTTER LIGHT

The shutter light indicates that the shutter is open.

REMOTE ACTUATION

Remote actuation is obtained with a single ground closure.

LINE VOLTAGE

115 V AC ±10% or 230 V AC ±10%.

C-31-PE ELECTRIC SHUTTER CAMERA, Pack-Film Back **$810**

C-31-RE ELECTRIC SHUTTER CAMERA, Roll-Film Back **$810**

C-31-GE ELECTRIC SHUTTER CAMERA, Graflok Back **$775**

CARRYING CASE

The carrying case holds the C-30A or C-31 Camera and all standard accessories including up to three Film Backs, extra bezels and extra film. The case is constructed of heavy-gage, high-impact plastic and has a vacuum-formed styrene liner. Dimensions are $7\frac{3}{16} \times 13\frac{3}{16} \times 15\frac{3}{16}$ inches.

Order 016-0126-00 . . . . . $38

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

CAMERA ADAPTERS

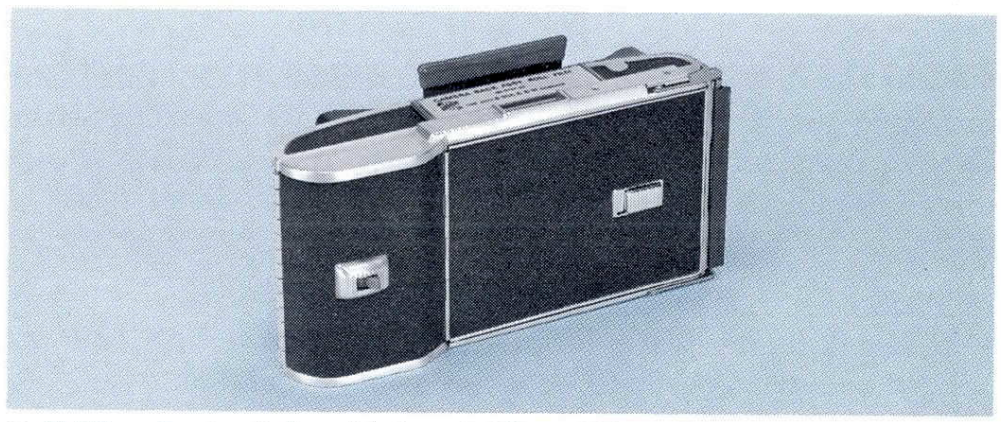
($16 each)

FOR OSCILLOSCOPE TYPE	PART NUMBER
310A, 317, 360	016-0241-00
321A	016-0242-00
Tektronix Oscilloscopes with 5-inch round CRT (except Type 519).	016-0243-00
Tektronix 560-Series with rectangular CRT, 529 and RM529.	016-0244-00
528, 601, 602, 7000-Series	016-0248-00

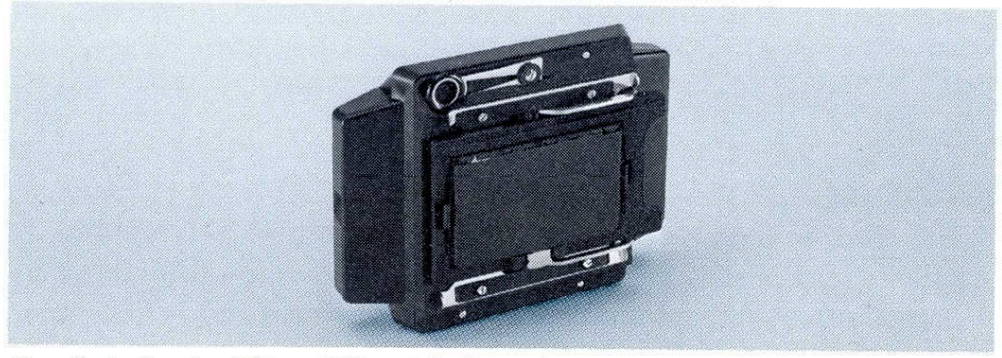
FILM BACKS

Three Film Backs provide flexibility of performance and films. Dark slides are included with all the film backs to permit changing backs without exposing any film.

Pack-Film Back, Polaroid Land Film, $3\frac{1}{4} \times 4\frac{1}{4}$, 8 exposure, order 122-0752-00 . . . . . $83
Focus Plate for above, order 387-0893-00 . . . . . $ 5



Roll-Film Back, Polaroid Land Film, $3\frac{1}{4} \times 4\frac{1}{4}$, 8 exposure, order 122-0754-00 . . . . . $83
Focus Plate for above, order 387-0460-00 . . . . . $ 5



Graflok Back, $2\frac{1}{4} \times 3\frac{1}{4}$ with focusing screen. Accepts standard cut-film holders, film-pack adapters, roll-film (120) holders, order 122-0755-00 . . . . . $50

NEW

C-50 Trace-Recording Cameras C-51

- ***TRACE-BRIGHTNESS PHOTOMETER***
- ***ELECTRICALLY-CONTROLLED SHUTTER***
- ***RANGE-FINDER FOCUSING***
- ***ACCURATE EXPOSURE CONTROL***
- ***COMPACT, LIGHTWEIGHT***

The C-50 and C-51 are compact, light-weight, trace-recording cameras designed primarily for use with all Tektronix 7000-Series Oscilloscopes. Differing only in the lens system, both cameras feature a trace-brightness photometer, range-finder focusing and accurate exposure control. The shutter is electrically actuated either remotely or by a push button on the control panel. Cameras may be ordered with either a Polaroid[1] Pack-Film Back or Roll-Film Back, or a Graflok[2] 4 x 5 Back. Optional film backs can be rapidly interchanged without refocusing the camera.

The C-50 is provided with a f/1.9, 1:0.7 lens for general-purpose trace recording. The C-51 uses an f/1.2, 1:0.5 lens providing the high-writing speed desired when the 7000-Series Oscilloscopes are operated single sweep at the fastest sweep rates. Both cameras mount directly to all 7000-Series Oscilloscopes.

MODES

A five-position switch turns the camera power on and selects normal, time, bulb or single-sweep operation.

FOCUS

The focus control is a spring-loaded knob that when pushed in projects two vertical bars of light on the CRT. By turning the focus control the light bars can be made to merge, indicating that the camera is properly focused. When the focus-control knob is released, the camera is then locked in focus and the lamps are turned off.

EXPOSURE

The proper combination of shutter speed and f number is selected to match the ASA film index and trace brightness as measured by the photometer. A thumbwheel inside the camera housing selects absorption filters for making an approximate visual color match of the photometer spot for the particular color of phosphor in use. Four filters are provided: P1, P2, P11, and P31. The ASA index is set, then the f knob is pushed in and turned to match the spot brightness to the trace brightness. When the f knob is released, it locks into the proper relation with the shutter-speed knob. Thus, if either is changed, the other follows to maintain a proper ratio.

CAMERA POWER AND SWEEP RESET CONNECTOR

A 3-pin connector on the bezel of the Tektronix 7000-Series Oscilloscopes provides +15 V, a ground connection to the camera and a sweep-reset pulse (in single-sweep function only) back to the oscilloscope.

Power Source

+15 V DC within 3% from the main frame at 400 mA or less.

Single-Shot Delay

Delays shutter closure 5 seconds (within 20%) after sweep ends, with plus gate applied.

Recovery Time

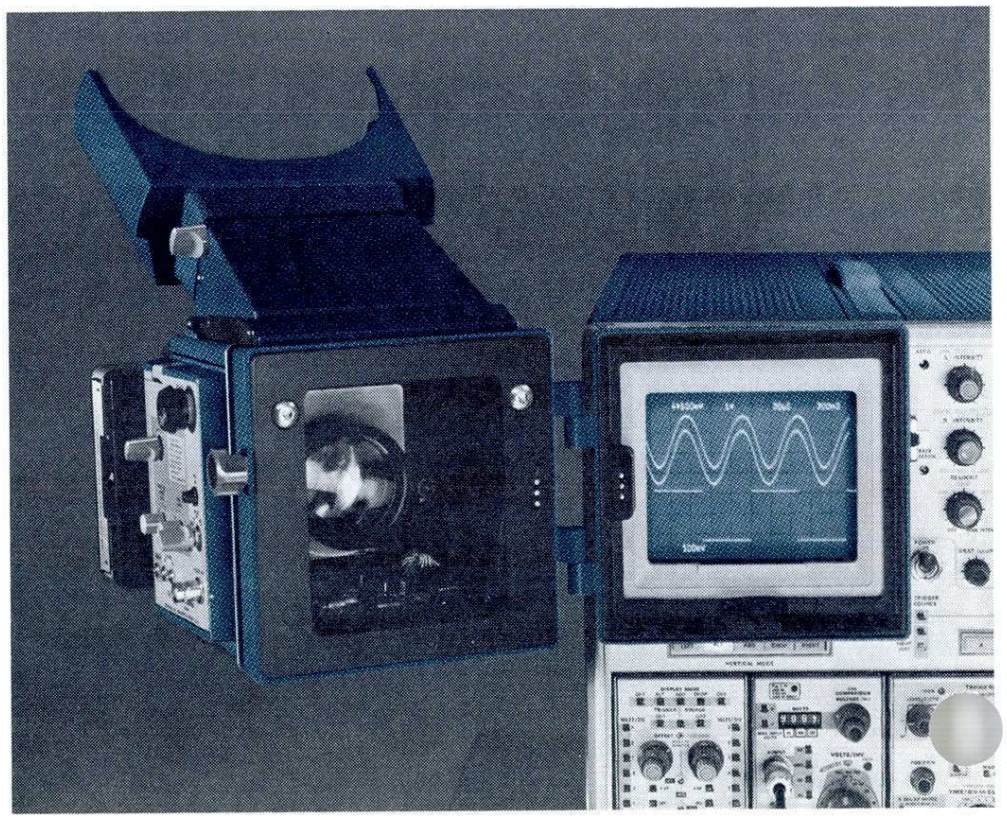
In all modes—two seconds or less between close and open.
In time mode only—at least 500 ms between open and close.

Shutter Closure Delay

In bulb mode only—200 ms or less after release of shutter button.

In single sweep only—5 seconds within 20% after sweep ends with plus gate applied.

All the above specifications are common to the C-50 and C-51.



Convenient mounting Swing-away hinging

[1]Registered Trademark Polaroid Corporation

[2]Registered Trademark Graflex, Inc.

NEW

C-50 Trace-Recording Cameras C-51

FOR C-50 ONLY

LENS
56-mm f/1.9 lens with magnification ratio of 1:0.7 within 2%.

SHUTTER SPEEDS
4, 2, 1, 1/2, 1/4, 1/8, 1/15, 1/30 and 1/60 second (accurate within 10% from +20°C to +30°C) plus Bulb and Time.

RELATIVE APERTURE RANGE
f/1.9, 2.8, 4.0, 5.6, 8, 11 and 16.

DIMENSIONS AND WEIGHTS

Length	10¾ inches (with viewing tunnel)	27.3 cm
Width	7½ inches (with pack back)	20.3 cm
Height	11½ inches (with viewing tunnel)	29.2 cm
Weight	7.5 lb (with pack back)	3.4 kg

INCLUDED STANDARD ACCESSORIES
Two instruction manuals (070-1011-00)

C-50-P CAMERA, Pack-Film Back **$700**
C-50-R CAMERA, Roll-Film Back **$700**
C-50-G CAMERA, 4 x 5 Graflok Back **$670**

FOR C-51 ONLY

LENS
56-mm f/1.2 lens with magnification ratio of 1:0.5 within 2%.

SHUTTER SPEEDS
4, 2, 1, 1/2, 1/4, 1/8, 1/15, 1/30 and 1/60 second (accurate within 10% from +20°C to +30°C) plus Bulb and Time.

RELATIVE APERTURE RANGE
f/1.2, 1.4, 1.9, 2.8, 4.0, 5.6, 8 and 11.

DIMENSIONS AND WEIGHTS

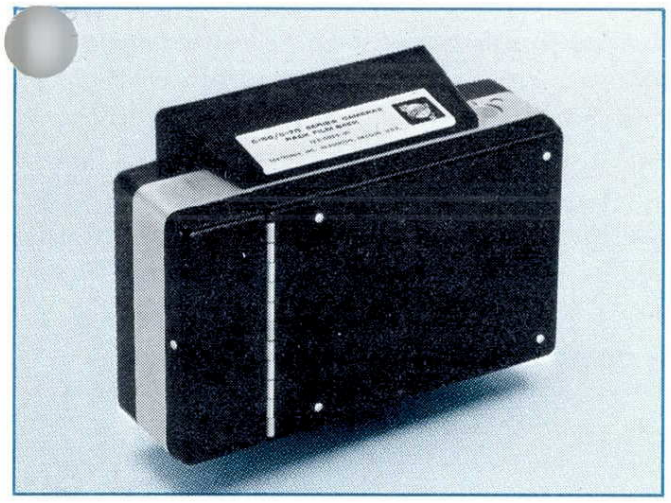
Length	10¾ inches (with viewing tunnel)	27.3 cm
Width	9¾ inches (with roll back)	24.8 cm
Height	11½ inches (with viewing tunnel)	29.2 cm
Weight	9.5 lb (with roll pack)	4.3 kg

INCLUDED STANDARD ACCESSORIES
Two instruction manuals (070-1011-00)

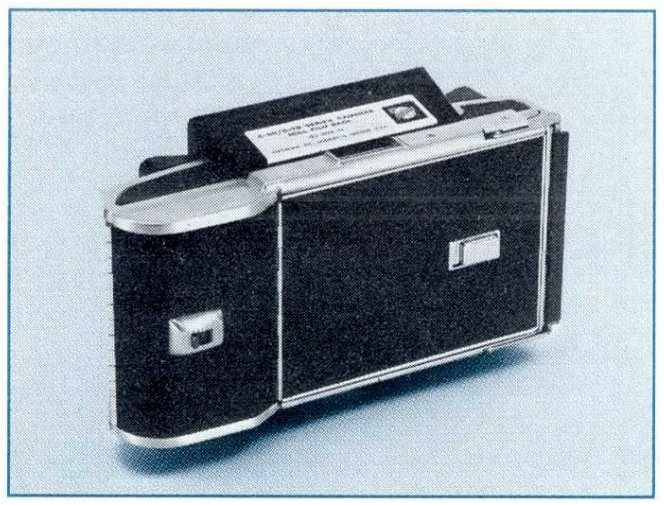
C-51-R CAMERA, Roll-Film Back **$900**
C-51-P CAMERA, Pack-Film Back **$900**
C-51-G CAMERA, 4 x 5 Graflok Back **$870**

FILM BACKS

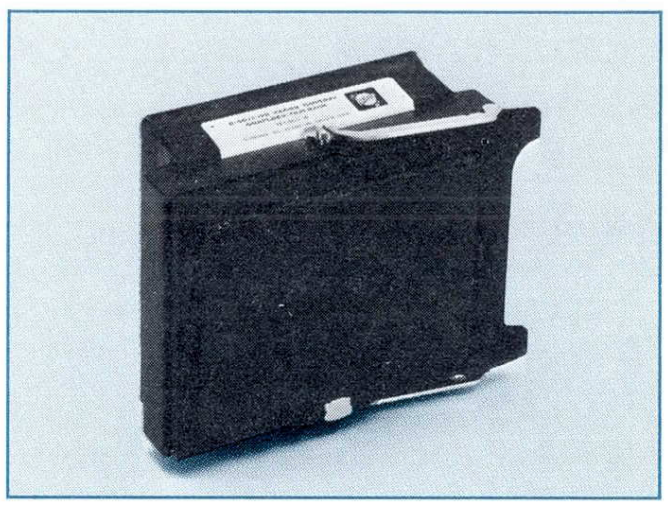
Three Film Backs provide flexibility of performance and films. Dark slides are included with Polaroid backs to permit changing backs without exposing any film.



Pack-Film Back, Polaroid[1] Land Film, 3¼ x 4¼, 8 exposure, order 122-0926-00 ..... $83



Roll-Film Back, Polaroid Land Film, 3¼ x 4¼, 8 exposure, order 122-0929-00 ..... $83



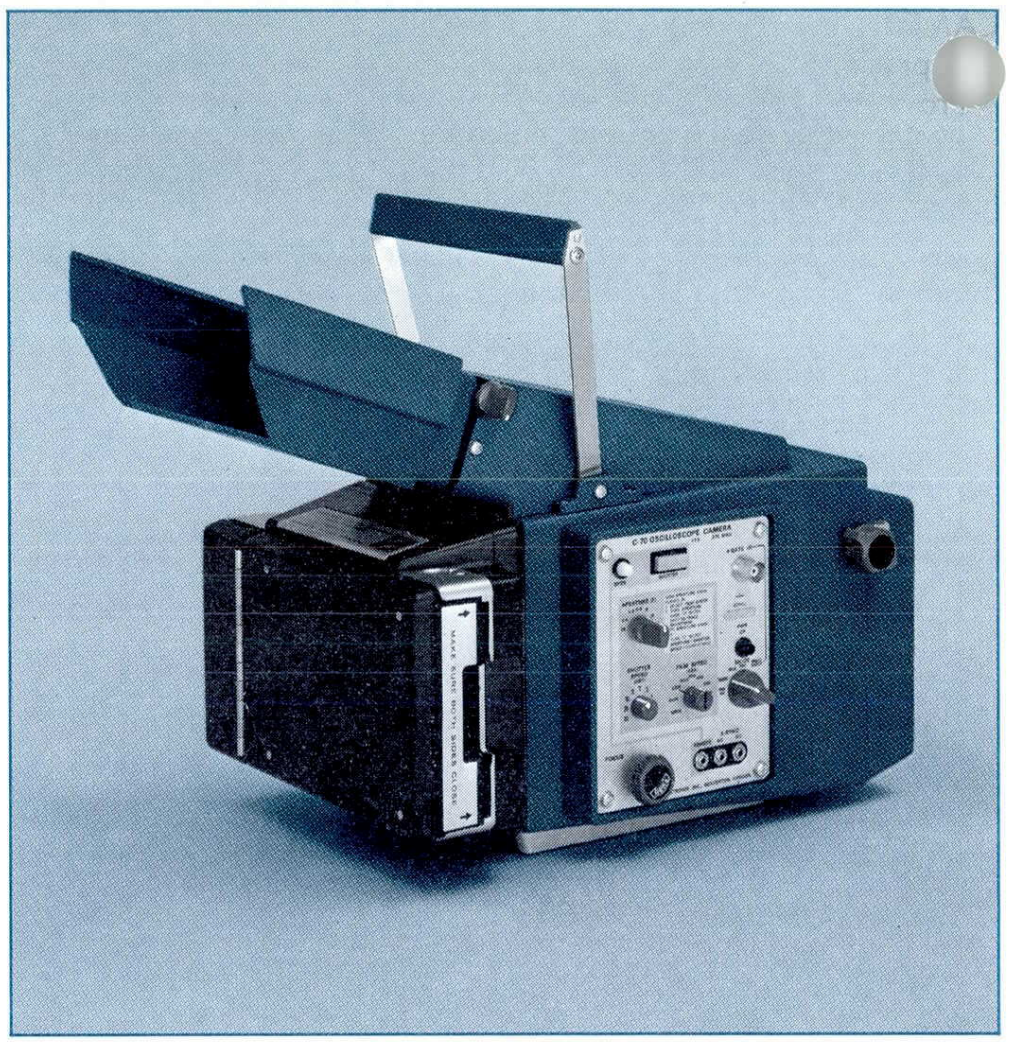
Graflok[2] Back, 4 x 5. Accepts Polaroid Land 4 x 5 film holder, standard cut-film holders, film-pack adapters, roll-film (120) holders, order 122-0931-00 ..... $50

U.S. Sales Prices F.O.B Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

NEW

C-70 Trace-Recording Camera C-70

- *TRACE-BRIGHTNESS PHOTOMETER*
- *ELECTRICALLY-CONTROLLED SHUTTER*
- *RANGE-FINDER FOCUSING*
- *ACCURATE EXPOSURE CONTROL*
- *COMPACT*



The C-70 is a compact trace-recording camera designed for use with Tektronix instruments which have 6½-inch CRT bezels, such as the Types 576, 5030 and 5031. The C-70 has an f/1.9 lens and a camera housing that accommodates either a Polaroid[1] Pack-Film Back or Roll-Film Back, or a Graflok[2] 4 x 5 Back. An analog exposure photometer mechanically selects the proper shutter speed and f number for a wide range of ASA film ratings and display luminances. The camera shutter is electrically actuated by a push button or remotely through an input jack, both of which are on the control panel. A special power-signal cable connects power from the oscilloscope to the camera and connects a signal from the camera for resetting the oscilloscope single sweep. The camera mounts directly to the 5000-Series Oscilloscopes and to the Type 576 Curve Tracer.

MODES

A five-position switch turns the camera power on and selects normal, time, bulb, or single-sweep operation. A power-on indicator lights when the mode switch is turned from the off position.

SHUTTER

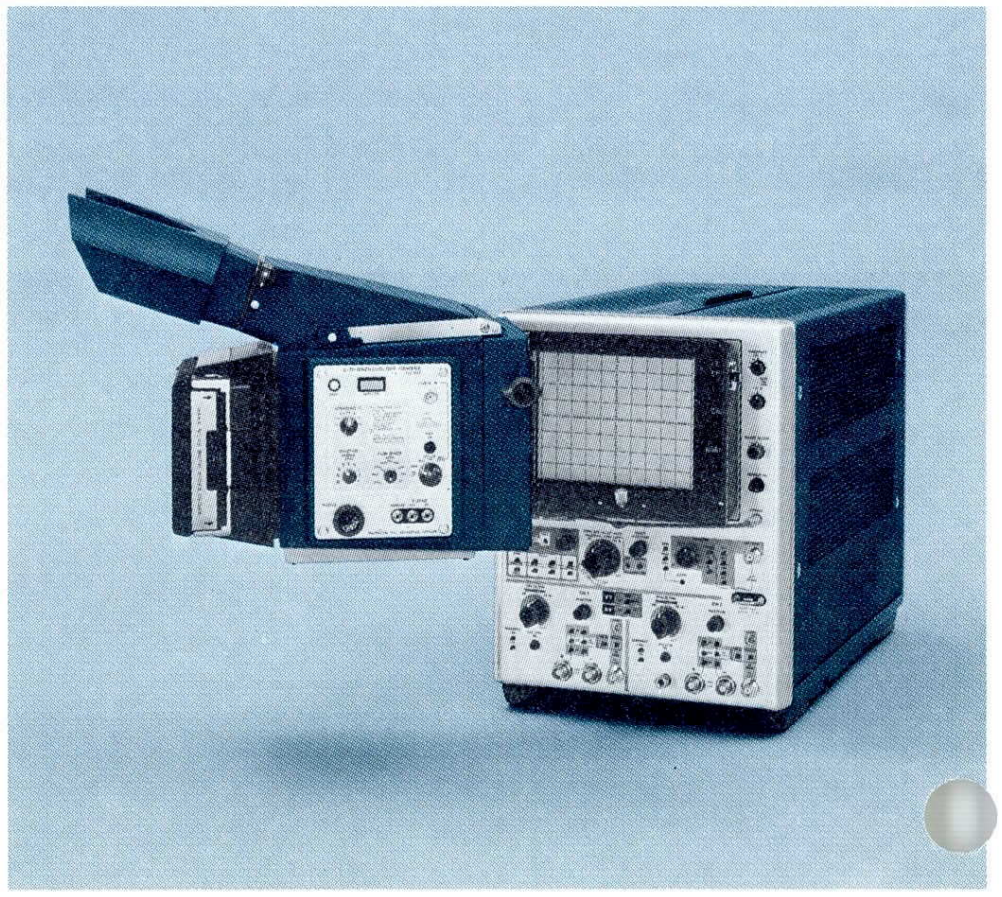
The shutter is electrically actuated in each operating mode. In the single-sweep mode, the shutter opens when the actuator button is depressed. Simultaneously the camera provides a pulse to reset the oscilloscope single sweep. The shutter remains open in this mode unless the camera is externally connected to the oscilloscope plus gate. When connected to the plus gate, the shutter is electronically closed approximately five seconds after the end of sweep (end of plus gate).

FOCUS

A spring-loaded knob which, when pushed in, projects two vertical bars of light onto the CRT. By turning the focus control, the light bars can be merged, indicating that the camera is properly focused. When the focus control is released, the camera is then locked in focus and the lamps are turned off.

EXPOSURE

The proper combination of shutter speed and f number is selected to match the ASA film index and trace brightness as measured by the photometer. A thumbwheel inside the camera housing selects absorption filters for an approximate visual color match of the photometer spot to the particular color of phosphor in use. Four filters are provided: P1, P2, P11, and P31. The exposure setting is obtained as follows: The film speed (ASA) is selected and the aperture (f) knob is pushed in to project a spot of light onto the CRT. The aperture knob is then turned to match the spot brightness to the trace brightness. When the aperture knob is released, it locks with the shutter speed knob. Thus, if either is changed, the other follows to maintain a proper relationship.



Convenient mounting, Swing-away hinging

[1]Registered Trademark Polaroid Corporation

[2]Registered Trademark Graflex, Inc.

NEW

C-70 Trace-Recording Camera C-70

CAMERA POWER AND SWEEP RESET

Applied from the oscilloscope by a power-signal cable. Provides +15 V, a ground connection and a sweep reset signal connection from the camera. The sweep reset function does not apply to the Type 576.

SHUTTER ACTUATOR:

Power Source

+15 V DC within 3% from the mainframe at 400 mA or less.

Single-Sweep Delay

Delays shutter closure 5 seconds (within 20%) after sweep ends, with + gate applied.

Recovery Time

In all modes—two seconds or less between open and close. In time mode only—at least 500 ms between open and close.

Shutter Closure Delay

In bulb mode only—250 ms or less after release of shutter button.

In single-sweep only—5 seconds (within 20%) after sweep ends with + gate applied.

LENS

67-mm f/1.9 lens with magnification ratio of 1:0.575 within 2%.

SHUTTER SPEEDS

4, 2, 1, 1/2, 1/4, 1/8, 1/15, 1/30 and 1/60 second (accurate within 10% from +20°C to +30°C) plus Bulb and Time.

RELATIVE APERTURE RANGE

f/1.9, 2.8, 4.0, 5.6, 8, 11 and 16.

DIMENSIONS AND WEIGHTS

Length	14.3 inches (with viewing tunnel)	36.3 cm
Width	8.2 inches (with pack back)	20.8 cm
Height	10.6 inches (with viewing tunnel)	26.9 cm
Weight	10.25 lb (with pack back)	4.6 kg

INCLUDED STANDARD ACCESSORIES

Two instruction manuals (070-1025-00).

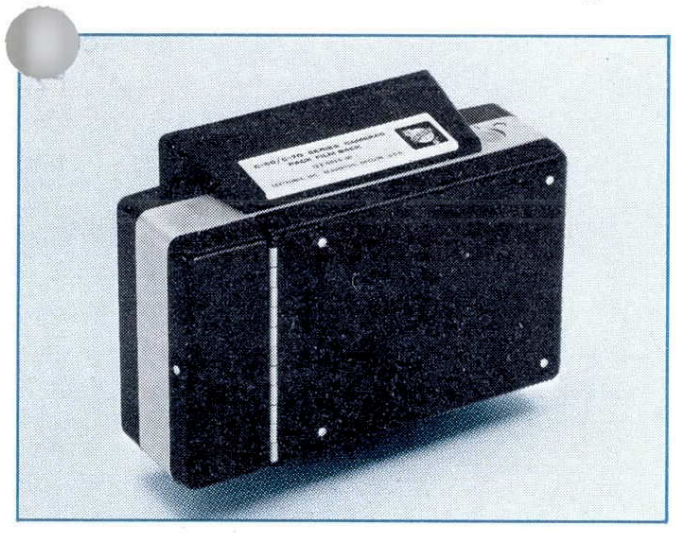
C-70-R CAMERA, Roll-Film Back **$785**

C-70-P CAMERA, Pack-Film Back **$785**

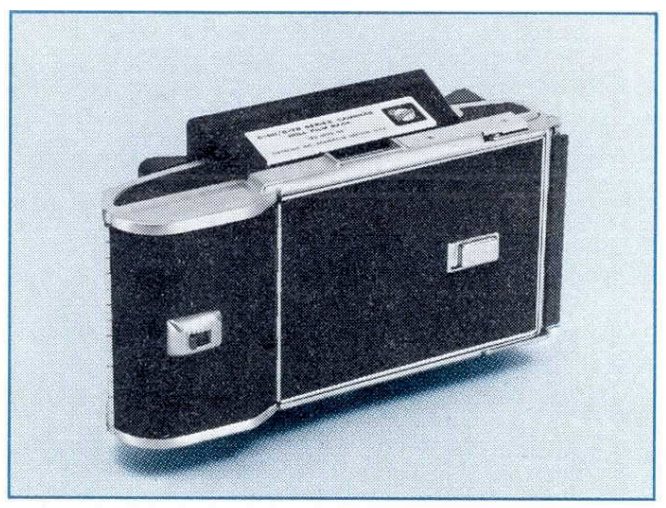
C-70-G CAMERA, 4 x 5 Graflok Back **$755**

FILM BACKS

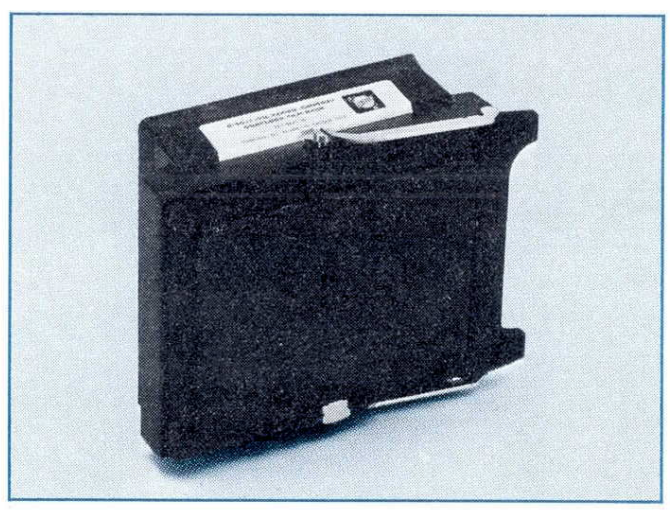
Three Film Backs provide flexibility of performance and films. Dark slides are included with Polaroid backs to permit changing backs without exposing any film.



Pack-Film Back, Polaroid Land Film, 3¼ x 4¼, 8 exposure, order 122-0926-00 ..... $83



Roll-Film Back, Polaroid Land Film, 3¼ x 4¼, 8 exposure, order 122-0929-00 ..... $83



Graflok Back, 4 x 5. Accepts Polaroid Land 4 x 5 film holder, standard cut-film holders, film-pack adapters, roll-film (120) holders, order 122-0931-00 ..... $50

U.S. Sales Prices F.O.B. Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

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Probe Reference Information

Tektronix offers a choice of voltage and current probes designed to be compatible with circuit measurement requirements. The probes are designed to monitor the signal source with minimum circuit loading while maintaining waveform fidelity.

A prime consideration in selecting the proper probe is the circuit loading effect of the oscilloscope/probe combination. The probe with the highest input impedance (lowest input capacitance and highest input resistance) will provide the least circuit loading. Typically, as frequency increases and risetime decreases, the capacitive loading becomes most important; at low frequencies the resistive loading becomes most important.

Capacitive loading of voltage probes is an important consideration when measuring fast-risetime pulses. The time required to charge the input capacitance of the probe from 10% to 90% is $t_r = 2.2\ R_{source}\ C_{probe}$. Current probes have minimum capacitive loading (typically 1 pF). With current probes the stray capacitance loading can be reduced by inserting the current probe on the ground or B+ side of the load resistor.

Probe attenuation ratio is also an important consideration. The oscilloscope must have enough gain to allow viewing of the attenuated signal.

When an attenuating probe is used with an oscilloscope, the input resistance and input capacitance of the oscilloscope represent R_2C_2, and the probe resistor and capacitor represent R_1C_1. When the probe is first connected to the oscilloscope, it must be compensated by applying a squarewave and adjusting the capacitor in the probe (C_1) until $R_1C_1 = R_2C_2$, which is indicated by the proper display on the oscilloscope. Improper compensation will result in either overshoot, roll-off, or incorrect signal amplitude when viewing a pulse of relatively narrow width.

If the probe is now removed from the oscilloscope on which it was compensated and connected to another one, THE PROBE MUST BE RECOMPENSATED. The input R and C of the second oscilloscope may be quite a bit different than the first, and C_1 would have to be readjusted so that R_1C_1 now equals the new R_2C_2.

To help you select the right probe for your application, the probe reference chart provides a quick comparison of Tektronix probe parameters. The following factors should be considered in making your selection:

1. Be sure the desired probe will match the input resistance and capacitance of the oscilloscope used, and is equipped with the proper connector.

2. Select a probe with adequate risetime and bandwidth for the oscilloscope and the application.

3. When considering input impedance, the probe with the lowest input capacitance will generally provide the most accurate measurements.

4. The instrument descriptions in this catalog list standard and optional accessories, and should be consulted for specific probe recommendations.

5. If you desire help in selecting the right probe for your application, please consult your local Tektronix Field Engineer, Representative or Distributor.

TEKTRONIX PROBES

(According to use area)

Recommended Use Area is the frequency range where the probe will have a minimum effect on the oscilloscope's measurement accuracy.

Probe Only Risetime is the risetime of the probe driven from a terminated 50-Ω source. From this figure the risetime of the probe/oscilloscope system may be calculated.

$$t_r^2\ _{system} = t_r^2\ _{probe} + t_r^2\ _{oscilloscope}$$

Bandwidth (3-dB down) of the probe/oscilloscope system may be calculated, knowing the system risetime and using the formula, (bw) $(t_r) = 0.35$.

Compensation Range of the probe is the range of oscilloscope input capacitances to which the probe can be adjusted.

CURRENT PROBES					
Recommended Use Area	**Probe Risetime**	**Minimum Defl Factor**	**Type**	**Price**	**Page**
35 kHz to 1 GHz	0.35 ns	5 mV/mA	P6040/CT 1	$ 40.00	418
1.2 kHz to 150 MHz	0.5 ns	1 mV/mA	P6041/CT 2	47.50	419
8.5 kHz to 150 MHz	2.2 ns	1 mA/mV	P6022/Passive Termination	165.00	416
100 Hz to 70 MHz	5 ns	1 mA/div	P6022/134 Amplifier	360.00	416
450 Hz to 60 MHz	5.8 ns	2 mA/mV	P6021/Passive Termination	121.00	416
DC to 50 MHz	7 ns	1 mA/div	P6042/Amplifier	690.00	420
12 Hz to 40 MHz	9 ns	1 mA/div	P6021/134 Amplifier	325.00	416

Probe Reference Information

VOLTAGE PROBES							
Recommended Use Area	Probe Only Risetime	Probe Input R, C	Compensation Range	Attenuation	Type	Price	Page
DC to 3.5 GHz	0.1 ns	0.7 pF, 500 Ω	N.A.	10X	P6034 Miniature	$ 44.00	410
DC to 1.7 GHz	0.2 ns	0.6 pF, 5 kΩ	N.A.	100X	P6035 Miniature	44.00	410
DC to 1 GHz	0.35 ns	2.8 pF, 1 MΩ	N.A.	5X	P6051 FET	375.00	426
DC to 500 MHz	0.7 ns	9.5 pF, 10 MΩ	15 to 24 pF	10X	P6053 Miniature	55.00	414
DC to 230 MHz	1.5 ns	5.5 pF, 10 MΩ	N.A.	1X	P6045 FET	435.00	422
DC to 150 MHz	1.2 ns	10 pF, 10 MΩ	15 to 20 pF	10X	P6047 Miniature	50.00	411
	2 ns	2.5 pF, 10 MΩ	8 to 50 pF	100X	P6009	66.00	403
DC to 100 MHz	2.6 ns	1 pF, 1 kΩ	14 to 21 pF	10X	P6048 Miniature	61.00	412
	3 ns	7.5 pF, 10 MΩ	8 to 50 pF	10X	P6008	46.50	403
	3.5 ns	10 pF, 1 MΩ	N.A.	0.1X	P6046 Differential Probe & Amplifier	800.00	424
DC to 50 MHz	2 ns	10 pF, 10 MΩ	14 to 21 pF	10X	P6010 Miniature	41.00	404
	4 ns	2.7 pF, 100 MΩ	12 to 50 pF	1000X	P6015 High Voltage Up to 40 kV	250.00	407
DC to 33 MHz	5 ns	7 pF, 10 MΩ	15 to 55 pF	10X	P6006	29.00	402
	5 ns	11.5 pF, 10 MΩ	15 to 47 pF	10X	P6012 Miniature	36.00	405
	7 ns	3 pF, 100 MΩ	12 to 60 pF	1000X	P6013A High Voltage Up to 12 kV	160.00	406
	7 ns	2 pF, 10 MΩ	15 to 55 pF	100X	P6007	29.00	402
	7 ns	12 pF, 8 MΩ	20 to 50 pF	10X	P6023	52.00	408
	8 ns	13.5 pF, 10 MΩ	15 to 55 pF	10X	P6052*	55.00	413
	10 ns	50 pF, 1 MΩ	N.A.	1X	P6027	16.50	409
	10 ns	50 pF, 1 MΩ	N.A.	1X	P6028	16.50	409
	12 ns	50 pF, 1 MΩ	N.A.	1X	P6011 Miniature	21.00	404
DC to 21 MHz	17 ns	13.5 pF, 10 MΩ	43 to 66 pF	10X	P6049 Miniature	36.00	412
DC to 6 MHz	60 ns	110 pF, 1 MΩ	N.A.	1X	P6052*	55.00	413

*The P6052 is a passive dual-attenuation probe.

Probing Considerations

Select the lowest impedance test point which provides a useful waveform. Although the input impedance of a probe is made as high as possible, it still will always have some finite effect on the circuit under test.

Be aware of the fact that the input impedance of a probe varies inversely with frequency. For example, a probe having a bandwidth of 50 MHz and an input resistance of 10 megohms (at DC), would only have an input resistance of approximately 1.5 kΩ at 50 MHz.

Probe loading effects can be minimized by selecting low-impedance test points. Usually, cathodes, emitters and sources should be chosen in preference to plates, collectors or drains; and inputs to high-impedance dividers in preference to mid-points. Circuits with low resistive peaking or compensation often produce displays which are difficult to evaluate properly in high-speed pulse work. It's often preferable to make current measurements than to attempt an accurate evaluation of inductive circuit voltage waveforms because of the effect of the probe input capacitance.

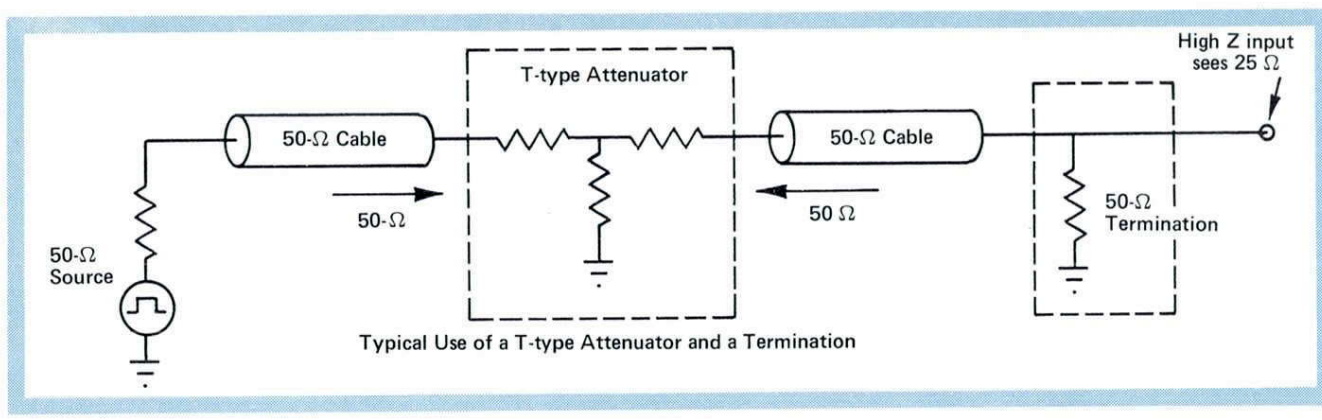
Time-delay differences must be considered, particularly in phase and time coincidence measurements, and differential applications. Low-impedance probes minimize these problems and high-speed differential probes are capable of matching probe characteristics to a high degree.

When using low-impedance probes keep in mind the resistive loading of the probe. For example, if observing the 1-volt 1%, 250-Ω 1% calibrator output of the Type 454 with the 1-kΩ P6048, correct calibration is indicated by a CRT display of 0.8 volts.

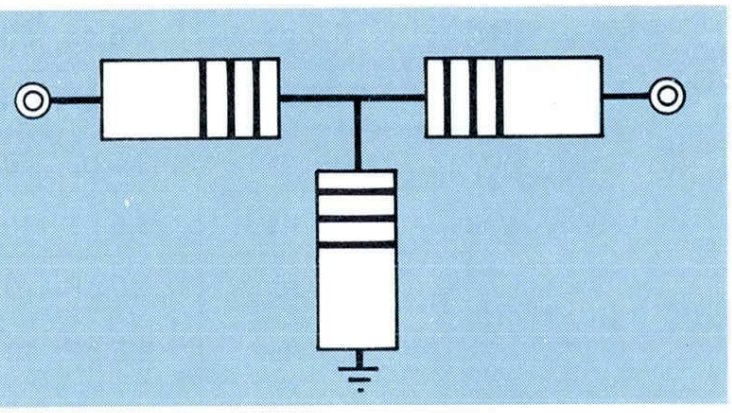
Grounding practices should always be kept in mind, particularly in high-impedance probe applications. Using as short a ground path as possible (preferably coaxial adapter or short bayonet connector) will minimize the effect of series inductance to the probe input. And, of course, in all probes that have variable compensation adjustments, check your compensation!

Attenuator Reference Information

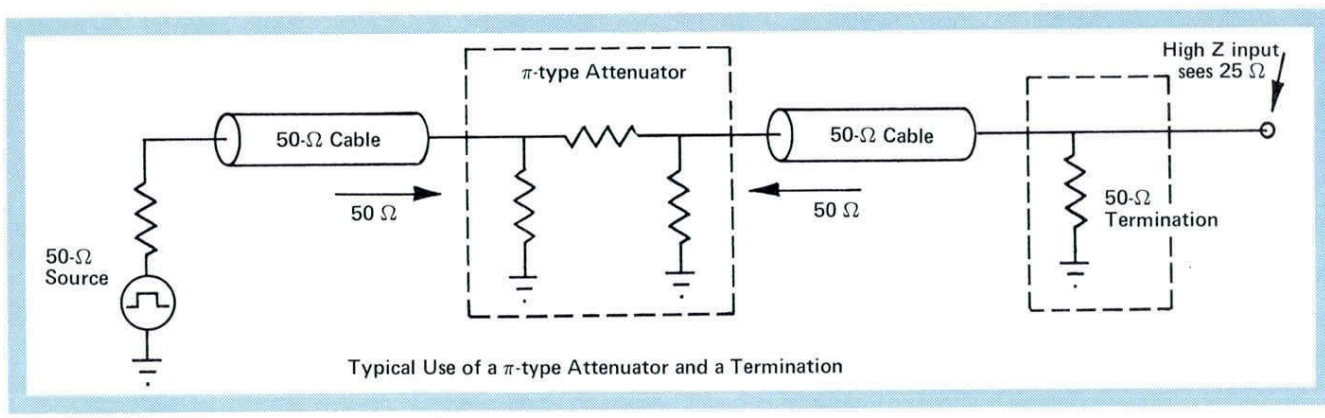
An attenuator is a network designed to introduce a known loss when inserted between resistive impedances which match the input and output impedances of the attenuator. Four basic types are typically used by Tektronix: "T" section; π section; minimum loss (L section); and distributed section. At frequencies up to 1 GHz, attenuators can be constructed with ordinary carbon resistors and are typically "T" type or minimum l In the gigahertz region attenuators are constructed of eit rod and disc resistors (T or π section) or card resistors (distributed section).



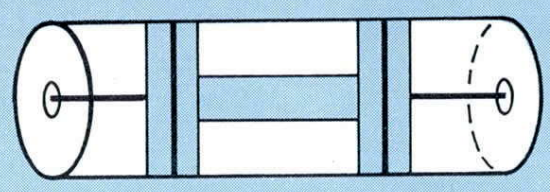
Typical Use of a T-type Attenuator and a Termination



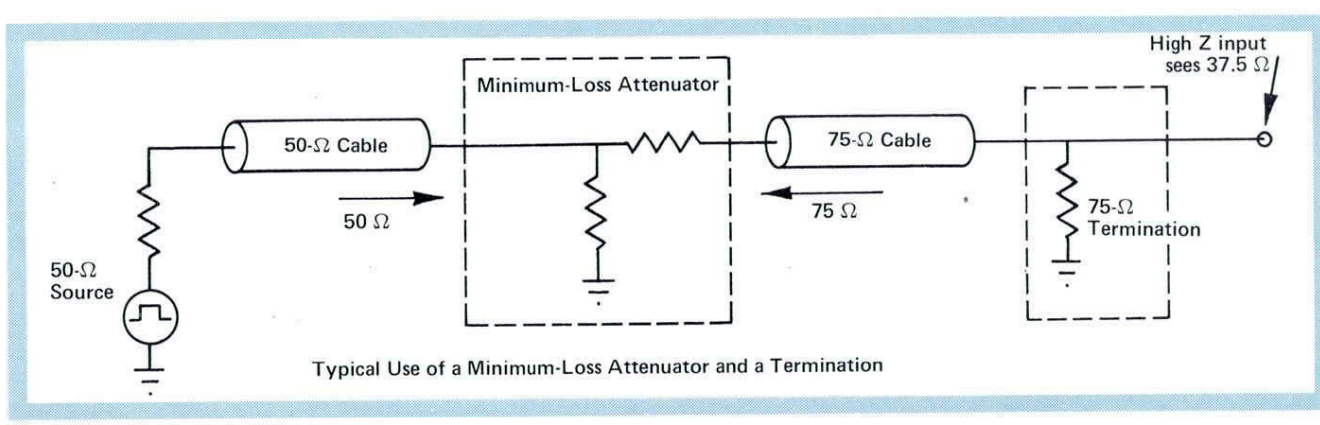
"T" TYPE—Maintain the proper impedance match between the signal source and the input to an instrument while attenuating the signal by an indicated ratio. T-type attenuators must have a load of the correct impedance to give the indicated attenuation ratio.



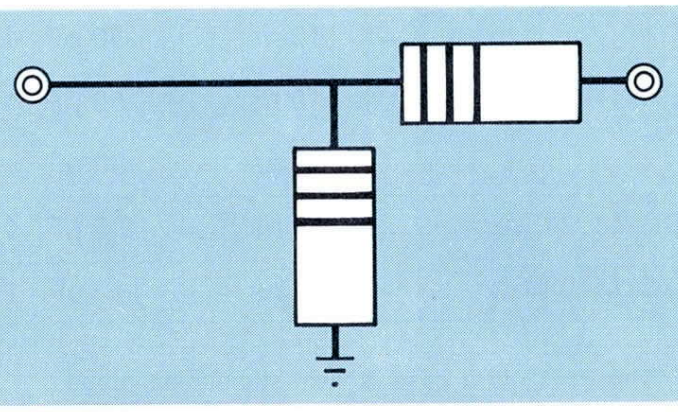
Typical Use of a π-type Attenuator and a Termination



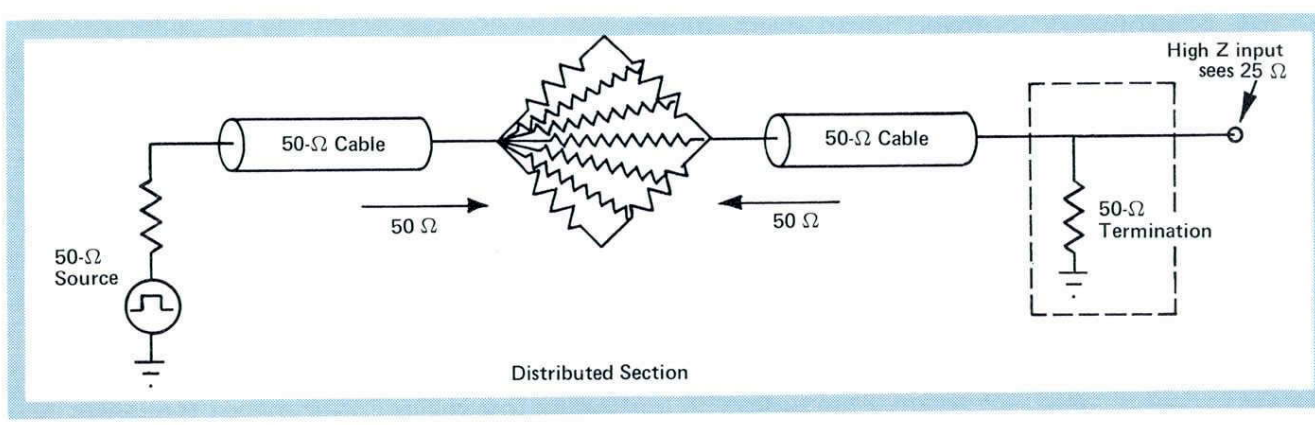
π TYPE—Maintain the proper impedance match between the signal source and the input to an instrument while attenuating the signal by an indicated ratio. π-type attenuators must have a load of the correct impedance to give the indicated attenuation ratio.



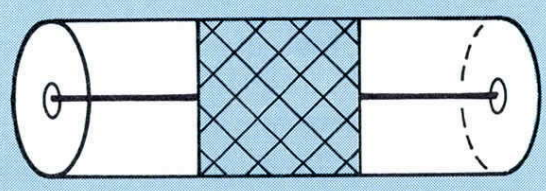
Typical Use of a Minimum-Loss Attenuator and a Termination



MINIMUM-LOSS TYPE—Provide a convenient means of matching a source or load with cables of different characteristic impedances. Tektronix minimum-loss attenuators assure proper matching, with a minimum loss of signal strength.



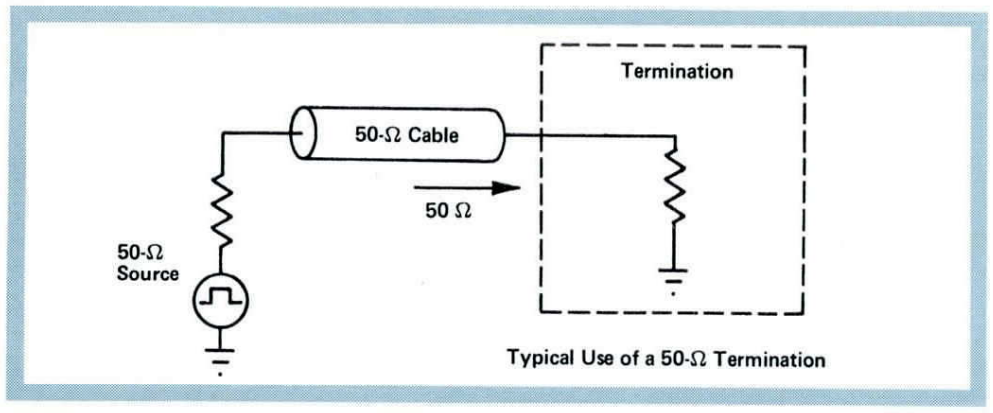
Distributed Section



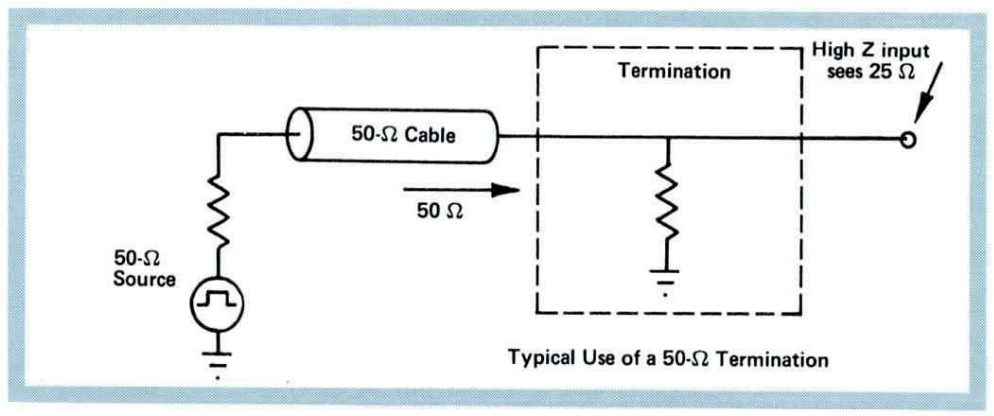
DISTRIBUTED TYPE—Maintain the proper impedance match between the signal source and the input to an instrument while attenuating the signal by an indicated ratio. Distributed type attenuators must have a load of the correct impedance to give the indicated attenuation ratio.

Termination Reference Information

TERMINATIONS—Terminate a cable in its characteristic impedance. Improper termination, or no termination, can cause ringing, reflections, and other adverse effects. Tektronix 50-Ω and 125-Ω instruments have built-in terminations.

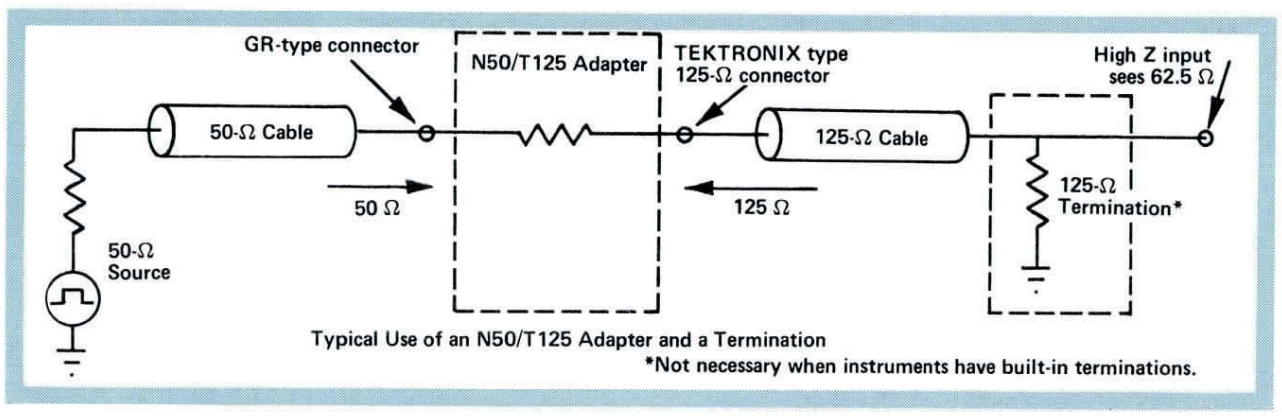


END LINE TERMINATION



FEEDTHROUGH TERMINATION

ADAPTERS—Connect cables of different characteristic impedances and different connectors. They are used only where impedance matching is not important. Tektronix adapters use the letter N to designate a non-terminated end and the letter T to designate a terminated end.



Scope-Mobile® Carts

The Type 200-1 Scope-Mobile® Cart is specifically designed for the Types 453 and 454 Portable Oscilloscopes, and the Type 491 Spectrum Analyzer. A separate version, the Type 200-2, is designed for use with the Type 422 Portable Oscilloscope.

These new oscilloscope carts occupy less than 18 inches of aisle space. With their large wheels and unique design, they can easily be moved up and down stairs. Friction locks on the oscilloscope tray permit the instrument to be positioned at any angle for convenient viewing. Storage space is provided at the base of the cart for accessories or associated instruments.

ADJUSTABLE TRAY friction-locks in any position from 0° to 60°. A finger-tip latch on the pedestal locks the tray for transporting.

MECHANICAL FEATURES include cast-aluminum construction with six-inch rubber wheels in the rear and two-inch swivel castors in front.

OVERALL DIMENSIONS are approximately 29 inches high by 17 inches wide by 19 inches deep. Storage area in the base measures 12 inches by 12 inches, and ¾ inches deep.

NET WEIGHT is 19 lb.

TYPE 200-1 SCOPE-MOBILE® CART
for Types 453, 454, 491 ..... **$95**

TYPE 200-2 SCOPE-MOBILE® CART
for Type 422 ..... **$95**

The Type 204-2 Scope-Mobile® Cart is specifically designed for the 7000-Series Oscilloscopes. The Type 204-2 features tilt-locking in any of nine tray positions. A large storage drawer for holding accessory items and a plug-in carrier for housing plug-in units are provided. Three AC receptacles are located at the rear of the storage drawer for supplying power to the oscilloscope and associated instruments. The Type 204-2 comes equipped with front-wheel brakes.

ADJUSTABLE TRAY tilt-locks in six 4.5° steps in the upward direction and two 4.5° steps in the downward direction from the horizontal axis.

MECHANICAL FEATURES include aluminum construction, 5-inch rubber wheels with front wheel brakes, and linoleum-topped steel shelf at the bottom. A latch-operated hold-down device insures that the oscilloscope is firmly secured to the adjustable tray.

NET WEIGHT is 48 lb.

OVERALL DIMENSIONS are approximately 36 inches high by 19-½ inches wide by 29 inches deep.

TYPE 204-2 includes plug-in carrier and storage drawer
..... **$155**

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Please refer to Terms and Shipment, General Information page.

Scope-Mobile® Carts

Seven models comprise the 201 through 205-Series Scope-Mobile® Carts featuring tilt locking in one of nine tray positions. These tilt-lock models include the Types 201-1, 201-2, 202-1, 202-2, 205-1, 205-2, 205-3. The three models ending with -1 have a storage drawer for holding accessory items. The models ending with -2 and -3 have a storage drawer and a plug-in carrier for housing plug-in units. Three AC-receptacles are located at the rear of the storage drawer for supplying power to the oscilloscope and associated instruments. All tilt-lock models come equipped with front-wheel brakes.

ADJUSTABLE TRAY tilt-locks in six 4.5° steps in the upward direction and two 4.5° steps in the downward direction from the horizontal axis.

MECHANICAL FEATURES include aluminum construction, 5-inch rubber wheels with front wheel brakes, and linoleum-topped steel shelf at the bottom.

OVERALL DIMENSIONS are approximately 36 inches high by 19½ inches wide by 29 inches deep for the 201-1, -2 and 202-1, -2; 36 inches high by 23½ inches wide by 29 inches deep for the 205-1, -2 and -3.

An optional strap assembly is available for securing various auxiliary instrument/oscilloscope combinations to the Scope-Mobile® upper tray.

Strap assembly, order 346-0070-01 ..... $8.50

Either the storage drawer or the storage drawer and plug-in carrier combination can be ordered separately to modernize older Scope-Mobile® Carts.

014-0012-00 drawer for 201-1 ..... $45
014-0013-00 drawer/plug-in carrier combination for 201-2 . $50
014-0014-00 drawer for 202-1 ..... $45
014-0015-00 drawer/plug-in carrier combination for 202-2 . $50
014-0032-00 drawer/1-, 80-, letter-series plug-in carrier combination for 205-2 ..... $50
014-0033-00 drawer/2-, 3-, 10-, 11-series plug-in carrier combination for 205-3 ..... $50

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Please refer to Terms and Shipment, General Information page.

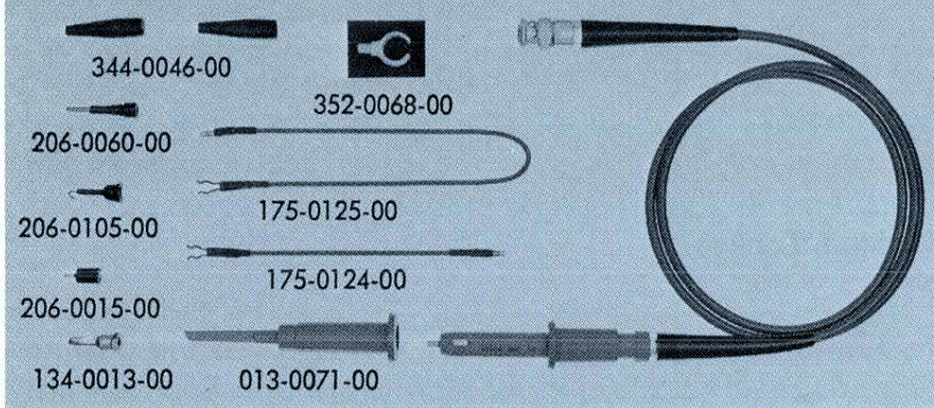
MODEL	PLUG-IN CARRIER	TRAY WIDTH	TRAY DESIGNED FOR TEKTRONIX OSCILLOSCOPE TYPE	BOTTOM TRAY DIMENSIONS**	NET WEIGHT	PRICE
201-1	NO	10½ in	503, 504, 515A, 516, 561B, 564B, 647A	15½ in x 25 in	≈37 lb	$145
201-2	Holds two 2-, 3-, 10-, or 11-series plug-ins				≈38½ lb	$155
202-1 MOD 52	NO	14¾ in	519	18½ in x 25 in	≈43¾ lb	$185
202-1	NO	14 in	502A*, 530-, 540-, 580-Series, 551, 575, 576, 5030, 5031	15½ in x 25 in	≈40¾ lb	$145
202-2	Holds two 1-, 80-, or letter-series plug-ins				≈42¾ lb	$155
205-1	NO	17¾ in	520, 521, 522, 556, 565, 568, and rackmount instruments	18½ in x 25 in	≈45¾ lb	$150
205-2	Holds three 1- or letter-series plug-ins				≈48¾ lb	$160
205-3	Holds four 2-, or 3-series plug-ins				≈48¾ lb	$160

**Requires special adapter, order 040-0365-00 .... $3.00.*

***Usable dimensions may be limited by height required.*

P6006 Voltage Probes P6007

DC-to-33 MHz 10X VOLTAGE PROBE



The P6006 is a general-purpose probe designed for use with Tektronix DC-to-33 MHz Oscilloscopes. The probe can be compensated to match all Tektronix Plug-Ins and Oscilloscopes with input capacitances of 15 pF to 55 pF and input resistance of 1 MΩ.

ATTENUATION is 10X.

INPUT RESISTANCE is 10 megohms.

INPUT CAPACITANCE for standard length probe is approximately 7 pF when used with an instrument having a 20-pF input capacitance; 8.5 pF for the 6-ft version, 11 pF for the 9-ft version, 13 pF for the 12-ft version.

PROBE RISETIME is approximately 5 ns.

TYPICAL RISETIME of probe, Type 1A2 Plug-In Unit, and Type 545B Oscilloscope is 12 ns.

VOLTAGE RATING is 600 V DC, AC peak, or DC and AC peak combined.*

NET WEIGHT is approx 8 ounces.

P6006 3.5-FT PROBE, order 010-0127-00 BNC or 010-0125-00 UHF **$29**

P6006 6-FT PROBE, order 010-0160-00 BNC or 010-0158-00 UHF **$29**

P6006 9-FT PROBE, order 010-0146-00 BNC or 010-0142-00 UHF **$29**

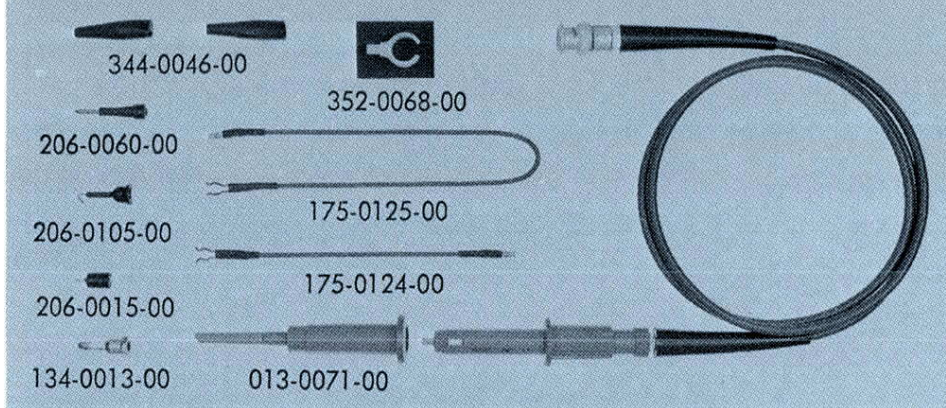
P6006 12-FT PROBE, order 010-0148-00 BNC or 010-0144-00 UHF **$29**

Includes: straight tip (206-0015-00); hook tip (206-0105-00); retractable hook tip (013-0071-00); spring tip (206-0060-00); banana plug (134-0013-00); two minigator clips (344-0046-00); probe holder (352-0068-00); 5-inch ground lead (175-0124-00); 12-inch ground lead (175-0125-00); instruction manual (070-0381-00).

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 5.7 MHz when working into a 20-pF input, or higher than 3.6 MHz when working into a 47-pF input.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

DC-to-33 MHz 100X VOLTAGE PROBE



The P6007 low input-capacitance, high-voltage (1.5-kV) probe is designed for use with Tektronix DC-to-33 MHz Oscilloscopes. The probe can be compensated to match all Tektronix Plug-Ins and Oscilloscopes with input capacitances of 15 pF to 55 pF and input resistance of 1 MΩ.

ATTENUATION is 100X.

INPUT RESISTANCE is 10 megohms.

INPUT CAPACITANCE for a standard length probe is approximately 2.0 pF when used with an instrument having a 20 pF input capacitance; 2.2 pF for the 6-ft version, 2.4 pF for the 9-ft version, 2.6 pF for the 12-ft version.

PROBE RISETIME is approximately 7 ns.

TYPICAL RISETIME of probe, Type 1A2 Plug-In Unit, and Type 545B Oscilloscope is approx 12.5 ns.

VOLTAGE RATING is 1.5 kV DC or AC RMS, 4.2 kV AC peak to peak.*

NET WEIGHT is approx 16 ounces.

P6007 3.5-FT PROBE, order 010-0150-00 BNC or 010-0134-00 UHF **$29**

P6007 6-FT PROBE, order 010-0165-00 BNC or 010-0162-00 UHF **$29**

P6007 9-FT PROBE, order 010-0152-00 BNC or 010-0136-00 UHF **$29**

P6007 12-FT PROBE, order 010-0154-00 BNC or 010-0138-00 UHF **$29**

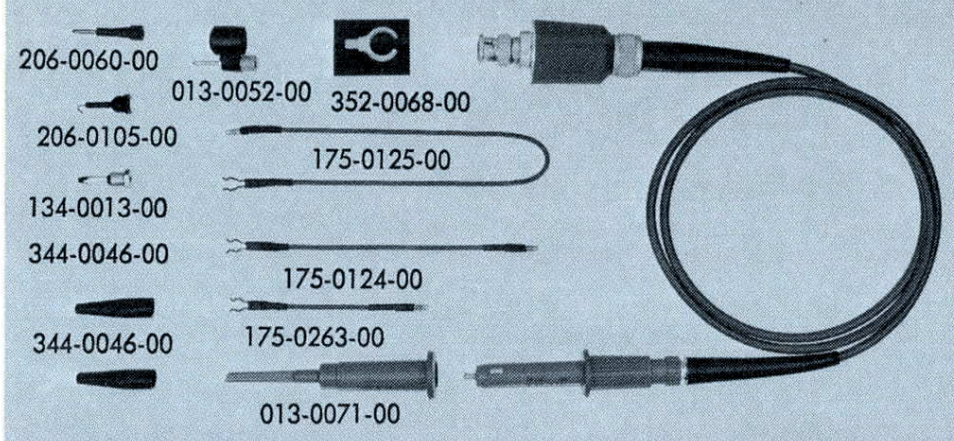
Includes: straight tip (206-0015-00); hook tip (206-0105-00); retractable hook tip (013-0071-00); spring tip (206-0060-00); banana plug (134-0013-00); two minigator clips (344-0046-00); probe holder (352-0068-00); 5-inch ground lead (175-0124-00); 12-inch ground lead (175-0125-00); instruction manual (070-0388-01).

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 200 kHz. At 10 MHz, the maximum allowable peak-to-peak voltage is 2 kV. Above 10 MHz, additional derating is required depending on the input capacitance of the plug-in or instrument used.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

P6008 Voltage Probes P6009

DC-to-100 MHz 10X VOLTAGE PROBE



The P6008 is a general purpose probe designed for use with Tektronix DC-to-100 MHz Oscilloscopes. The probe can be compensated to match plug-ins and oscilloscopes with input capacitances of 8 pF to 50 pF and input resistance of 1 MΩ.

ATTENUATION is 10X

INPUT RESISTANCE is 10 megohms.

INPUT CAPACITANCE is approximately 7.5 pF.

PROBE RISETIME is less than 3 ns.

TYPICAL RISETIME of probe, Type 82 Plug-In Unit, and Type 580-Series Oscilloscope is 5 ns.

VOLTAGE RATING is 600 V DC, AC peak, or DC and AC peak combined.*

CABLE is 3.5 ft long, terminated with a BNC connector.

NET WEIGHT is approx 8 ounces.

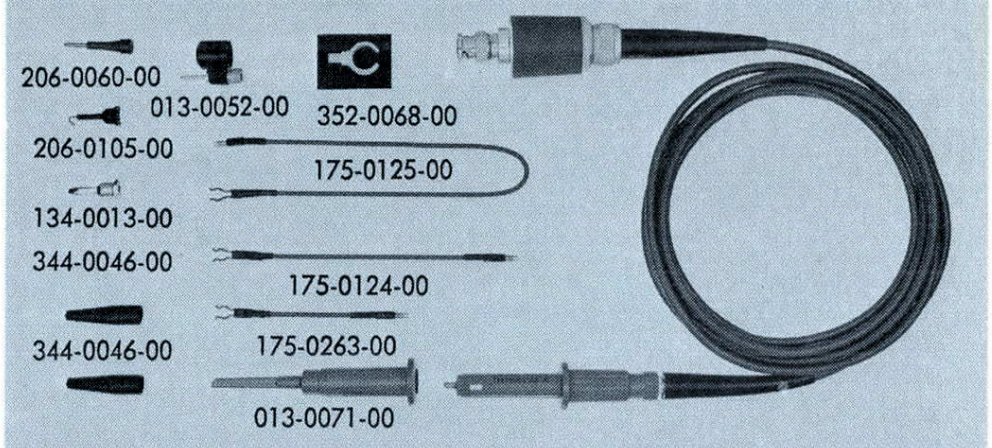
P6008 PROBE, order 010-0129-00 . . . . . **$46.50**
Includes: bayonet adapter (013-0052-00); hook tip (206-0105-00); retractable hook tip (013-0071-00); spring tip (206-0060-00); straight tip (206-0015-00); banana plug (134-0013-00); two minigator clips (344-0046-00); probe holder (352-0068-00); 3-inch ground lead (175-0263-00); 5-inch ground lead (175-0124-00); 12-inch ground lead (175-0125-00); instruction manual (070-0362-01).

OPTIONAL ACCESSORIES—see probe accessories at the rear of probe section.

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 20 MHz. At 40 MHz, the maximum allowable peak-to-peak voltage is 300 V.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

DC-to-150 MHz 100X VOLTAGE PROBE



The P6009 low input capacitance, high-voltage (1.5-kV) probe is designed for use with Tektronix DC-to-150 MHz Oscilloscopes. The probe can be compensated to match plug-ins and oscilloscopes with input capacitance of 8 pF to 50 pF and input resistance of 1 MΩ.

ATTENUATION is 100X.

INPUT RESISTANCE is 10 megohms.

INPUT CAPACITANCE is 2.5 pF.

PROBE RISETIME is approximately 2 ns.

TYPICAL RISETIME of probe, Type 82 Plug-In Unit, and 580-Series Oscilloscope is 4.5 ns.

VOLTAGE RATING is 1.5 kV DC or AC RMS, 4 kV AC peak to peak.*

CABLE is 9 ft long, terminated with a BNC connector.

NET WEIGHT is approx 16 ounces.

P6009 PROBE, order 010-0140-00 . . . . . **$66**

P6009 PROBE, for the Types 10A2A and 454
order 010-0170-00 . . . . . **$66**
Includes: bayonet adapter (013-0052-00); hook tip (206-0105-00); retractable hook tip (013-0071-00); spring tip (206-0060-00); straight tip (206-0015-00); banana plug (134-0013-00); two minigator clips (344-0046-00); probe holder (352-0068-00); 3-inch ground lead (175-0263-00); 5-inch ground lead (175-0124-00); 12-inch ground lead (175-0125-00); instruction manual (070-0401-00).

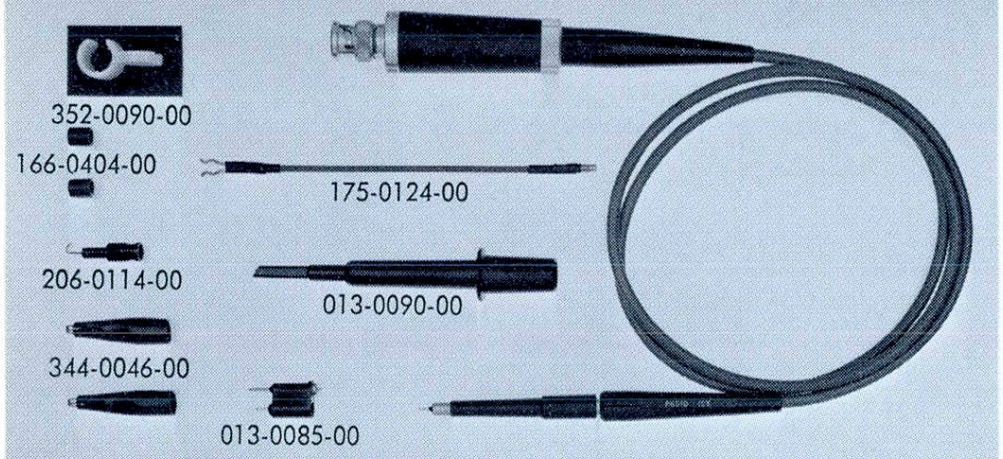
OPTIONAL ACCESSORIES—see probe accessories at the rear of probe section.

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 300 kHz. At 40 MHz, the maximum allowable peak-to-peak voltage is 575 V.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

P6010 Voltage Probes P6011

DC-to-50 MHz 10X VOLTAGE PROBE



The P6010 is a miniature passive probe designed for use with Tektronix DC-to-50 MHz oscilloscopes. The probe is easily compensated for use with any instrument having an input capacitance of 14 to 21 pF.

Extra small in size, the P6010 is well suited for servicing subminiature circuits where easy access is required. In addition to the standard 3.5-ft length, the probe is available with a 6-ft or 9-ft cable at no additional cost.

ATTENUATION is 10X.

INPUT RESISTANCE is 10 megohms.

INPUT CAPACITANCE for the standard length probe is approximately 10 pF when used with instruments having a 14 to 21-pF input capacitance; 12 pF for the 6-ft version, 15.5 pF for the 9-ft version.

PROBE RISETIME is less than 2 ns.

TYPICAL RISETIME of probe with Type 453 Oscilloscope is 7 ns.

VOLTAGE RATING is 500 V DC, AC peak, or DC and AC peak combined.*

STANDARD CABLE is 3.5 ft long, terminated with a BNC connector.

NET WEIGHT is approx 14 ounces.

P6010 3.5-FT PROBE, order 010-0188-00 . . . . . $41

P6010 6-FT PROBE, order 010-0185-00 . . . . . $41

P6010 9-FT PROBE, order 010-0201-00 . . . . . $41

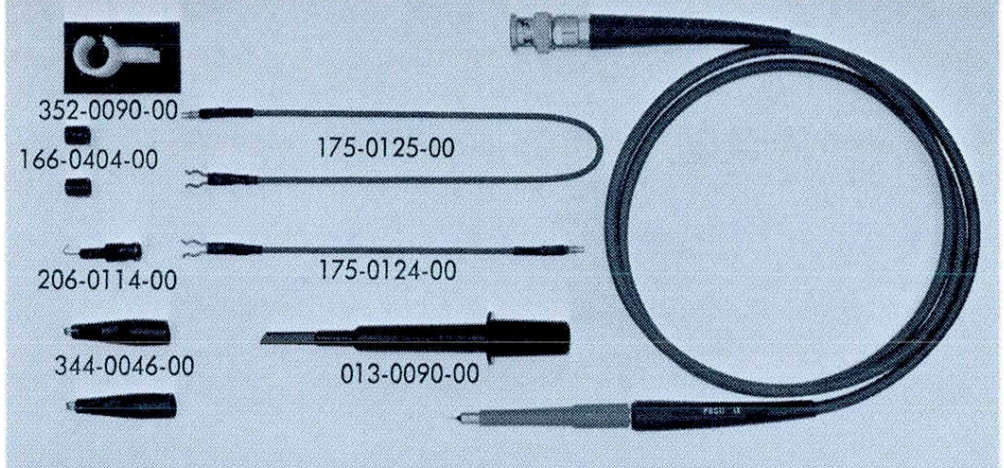
Includes hook tip (206-0114-00); retractable hook tip (013-0090-00); bayonet ground adapter (013-0085-00); minigator clip (344-0046-00); probe holder (352-0090-00); 5-inch ground lead (175-0124-00); two insulating tubes (166-0404-00); instruction manual (070-0495-01).

OPTIONAL ACCESSORIES—see probe accessories at the rear of probe section.

*Peak voltage derating is necessary for CW frequencies higher than 2.5 MHz. At 20 MHz, the maximum allowable peak voltage is 175 V; 60 V at 60 MHz.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

DC-to-33 MHz 1X VOLTAGE PROBE



The P6011 1X Passive Probe can be used with all Tektronix general-purpose oscilloscopes. Like the P6010, the small size of the probe body makes it ideal for working on compact circuitry.

The probe cable utilizes a resistive center conductor for damping critical reflections, insuring maximum bandwidth. In addition to the standard 3.5-ft length, the probe is available with a 6-ft or 9-ft cable at no additional cost.

ATTENUATION is 1X.

INPUT RESISTANCE is 1 megohm, instrument input R included.

INPUT CAPACITANCE for standard length probe is appro. 28 pF; 48 pF for the 6-ft version, instrument excluded.

PROBE RISETIME for the standard cable length is less than 12 ns working into a plug-in with an input capacitance of 15 pF; less than 15 ns working into a plug-in with an input capacitance of 20 pF. The probe risetime of the 6-ft version is less than 15 ns into 15 pF or less than 17 ns into 20 pF. The probe risetime of the 9-ft version is less than 23 ns into 15 pF or less than 25 ns into 20 pF.

VOLTAGE RATING is 600 V DC, AC peak, or DC and AC peak combined.*

STANDARD CABLE is 3.5 ft long with a BNC connector.

NET WEIGHT is approx 12 ounces.

P6011 3.5-FT PROBE, order 010-0193-00 . . . . . $21

P6011 6-FT PROBE, order 010-0190-00 . . . . . $21

P6011 9-FT PROBE, order 010-0229-00 . . . . . $21

Includes: hook tip (206-0114-00); retractable hook tip (013-0090-00); two minigator clips (344-0046-00); probe holder (352-0090-00); two insulating tubes (166-0404-00); 5-inch ground lead (175-0124-00); 12-inch ground lead (175-0125-00); one insulating sleeve (166-0433-00)†; instruction manual (070-0512-01).

OPTIONAL ACCESSORIES—see probe accessories at the rear of probe section.

*Peak voltage derating is necessary for CW frequencies higher than 0.5 MHz. When the probe is used with a plug-in having an input C of 20 pF, the maximum allowable peak voltage at 1 MHz is 510 V. At 5 MHz, the maximum is 100 V; 46 V at 10 MHz. When the probe is used with a plug-in having a 47-pF input, the allowable voltage will be lower by a ratio of 1:3.

†Not shown.

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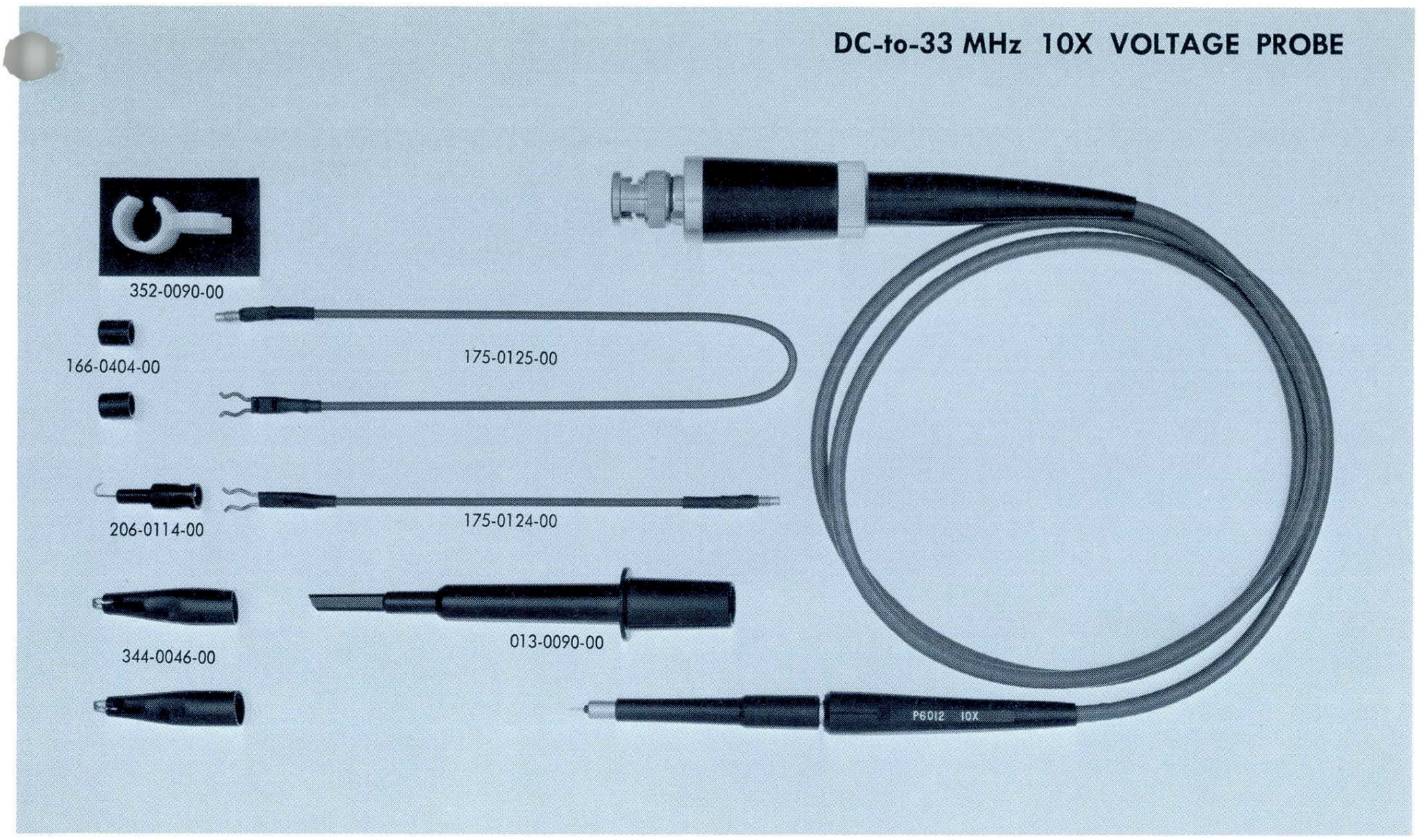
Please refer to Terms and Shipment, General Information page.

DC-to-33 MHz 10X VOLTAGE PROBE



The new P6012 is a miniature general-purpose probe designed for use with oscilloscopes having bandwidths up to 33 MHz. The probe can be compensated to match all Tektronix plug-ins and oscilloscopes with input capacitances of 15 to 47 pF and input resistance of 1 MΩ.

Very small in size, the P6012 is well suited for applications involving subminiature circuitry. The probe is available with a 3.5-ft, 6-ft, or 9-ft cable.

ATTENUATION is 10X.

INPUT RESISTANCE is approximately 10 megohms.

INPUT CAPACITANCE of probe with 3.5-ft cable is 11.5 pF or less; 14.5 pF or less for the 6-ft version; 17.5 pF or less for the 9-ft version.

PROBE RISETIME is 5 ns or less with 3.5-ft cable, 6 ns or less with 6-ft cable, 6.5 ns or less with the 9-ft cable.

VOLTAGE RATING is 500 V DC and AC peak combined.*

PROBE CABLE is terminated with a BNC connector.

NET WEIGHT is approx 15 ounces.

P6012 3.5-FT PROBE, order 010-0203-00 . . . . . **$36**
P6012 6-FT PROBE, order 010-0209-00 . . . . . **$36**
P6012 9-FT PROBE, order 010-0231-00 . . . . . **$36**

Includes: hook tip (206-0114-00); retractable hook tip (013-0090-00); two minigator clips (344-0046-00); probe holder (352-0090-00); 5-inch ground lead (175-0124-00); 12-inch ground lead (175-0125-00); two insulating tubes (166-0404-00); instruction manual (070-0601-02); insulating ground sleeve, not shown (166-0433-00).

OPTIONAL ACCESSORIES—see probe accessories at the rear of probe section.

*Peak voltage derating is necessary for CW frequencies higher than 4 MHz. At 15 MHz the maximum allowable peak voltage is 210 V; 95 V at 33 MHz.

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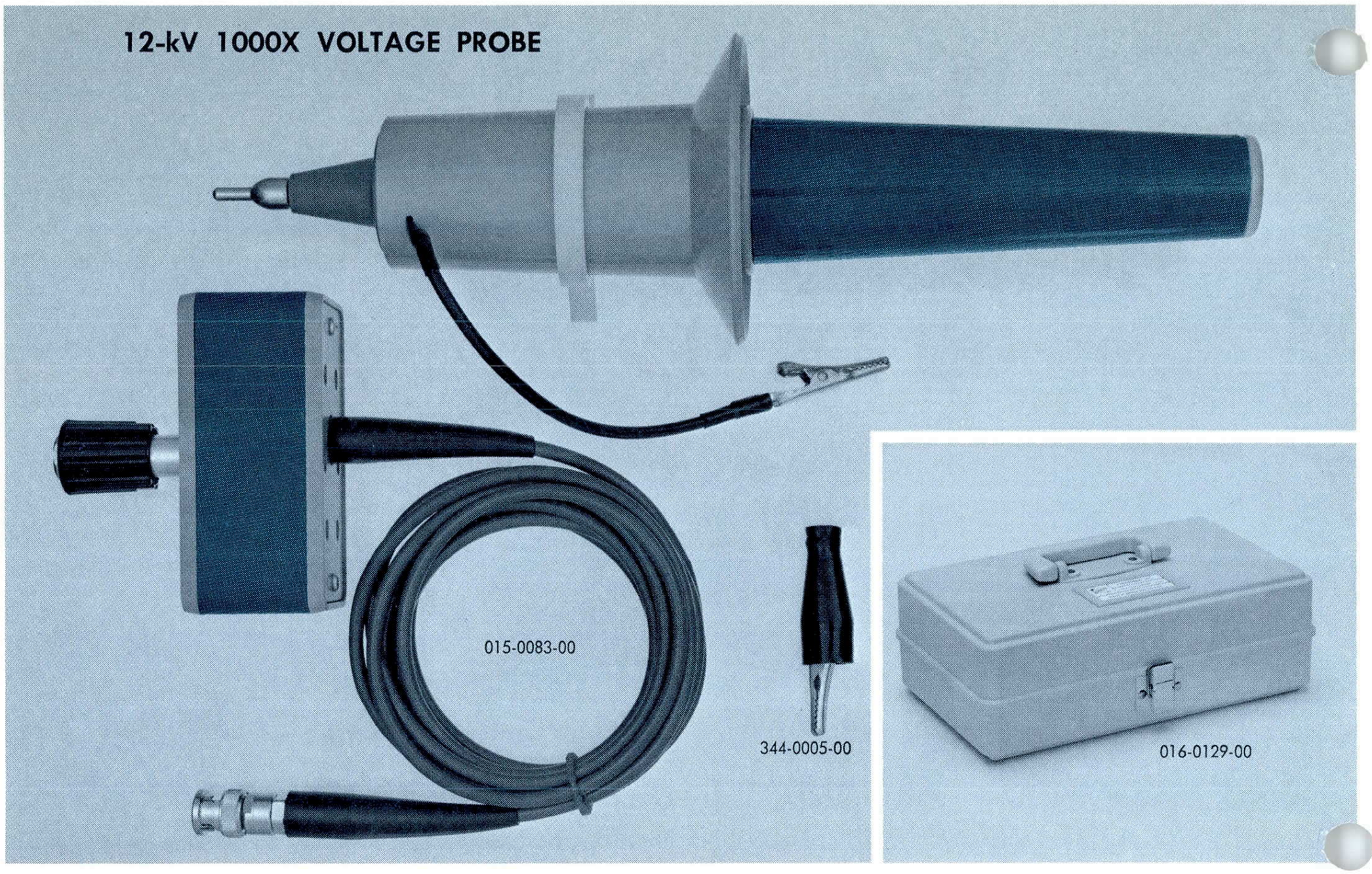
Please refer to Terms and Shipment, General Information page.



The P6013A provides 1000X attenuation for oscilloscope measurements of high amplitude waveforms or DC potentials up to 12 kV. Pulse frequency can be up to 100 kHz at 12 kV.

The probe can be compensated for oscilloscope input capacitance up to 60 pF and input resistance of 1 MΩ.

ATTENUATION is 1000X.

INPUT RESISTANCE is 100 megohms.

INPUT CAPACITANCE of probe with 10-ft cable is 3 pF; 3.5 pF with 25-ft cable.

PROBE RISETIME is 7 ns or less with 10-ft cable, 13.5 ns or less with 25-ft cable.

TYPICAL RISETIME of 10-ft probe, Type 1A1 Plug-In Unit, and Type 545B Oscilloscope is 13 ns.

VOLTAGE RATING is 12 kV DC, peak pulse, or peak AC.*

CABLES are 10-ft or 25-ft long, terminated with a LOCKING BNC or UHF connector.

NET WEIGHT is approx 5½ pounds.

P6013A 10-FT PROBE, order 010-0177-01 LOCKING BNC or 010-0181-01 UHF **$160**

Includes: compensating box (015-0083-00 BNC) or (015-0081-00 UHF); alligator clip (344-0005-00); probe holder (352-0056-00); carrying case (016-0129-00); instruction manual (070-0603-00).

P6013A 25-FT PROBE, order 010-0175-01 LOCKING BNC or 010-0179-01 UHF **$160**

Includes: compensating box (015-0084-00 BNC) or (015-0082-00 UHF); alligator clip (344-0005-00); probe holder (352-0056-00); carrying case (016-0129-00); instruction manual (070-0603-00).

OPTIONAL ACCESSORIES—see probe accessories at the rear of probe section.

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 100 kHz. At 1 MHz, the maximum allowable peak-to-peak voltage is 5.5 kV.

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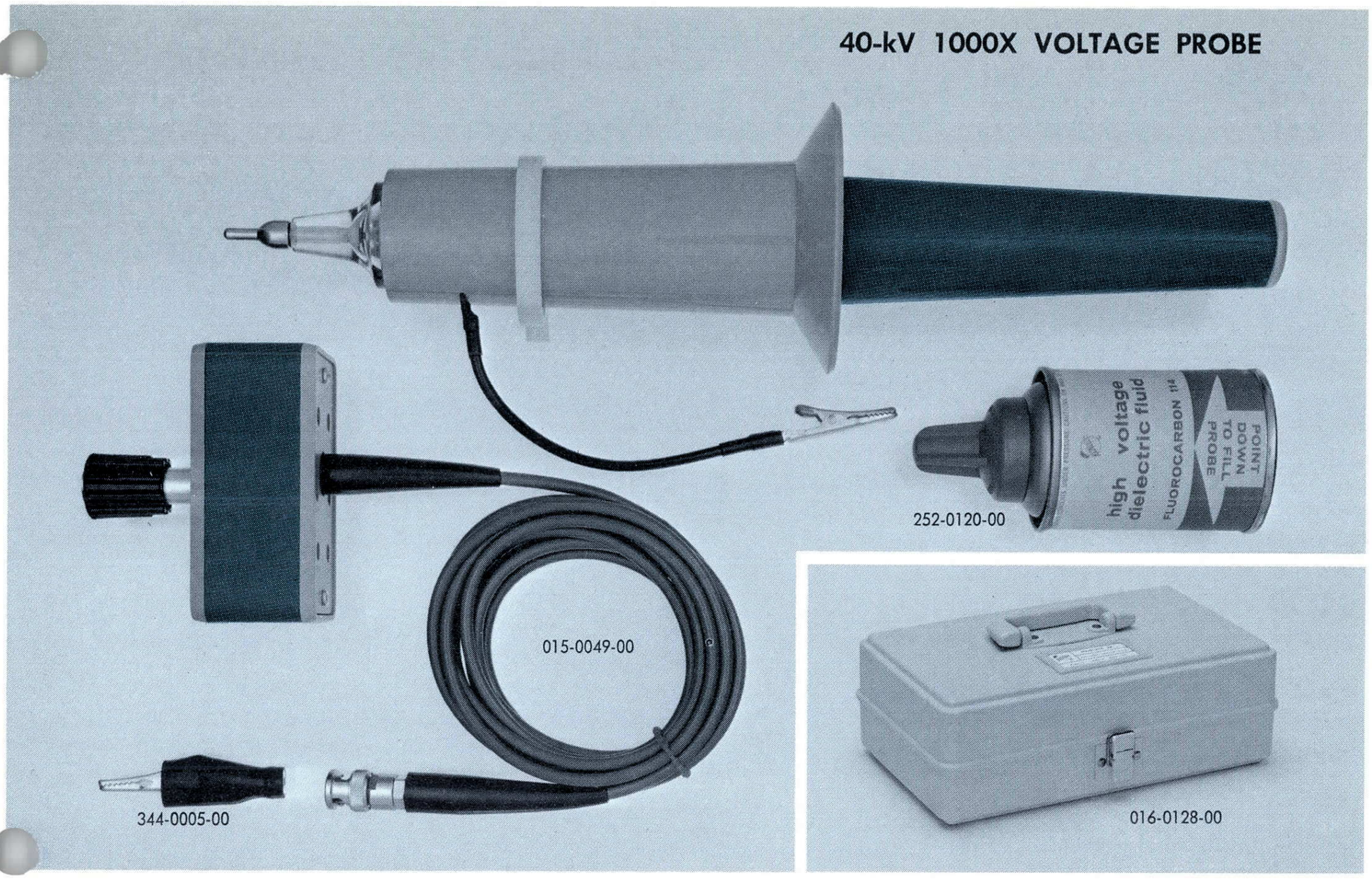
Please refer to Terms and Shipment, General Information page.

High Voltage Probe

P6015



The P6015 provides 1000X attenuation for oscilloscope measurements up to 40-kV peak. Voltage or duty cycle derating is necessary for RF voltages at frequencies over 100 kHz, or in environmental temperatures above 25°C.

The probe time constant can be adjusted to equal the oscilloscope input time constant for instruments with 12-pF to 50-pF input capacitance.

ATTENUATION is 1000X.

INPUT RESISTANCE is 100 megohms.

INPUT CAPACITANCE is approximately 2.7 pF.

PROBE RISETIME is approximately 4 ns.

TYPICAL RISETIME of the probe, Type 1A1 Plug-In Unit, and Type 545B Oscilloscope is 11.5 ns.

TEMPERATURE RANGE is 10° C to 55° C environmental temperature. Approximate temperature coefficient of nose resistor is —0.15% per degree centigrade. Calibration adjustments are necessary when environmental or nose resistor temperature changes.

VOLTAGE RATING is 40 kV peak AC or pulse, 20 kV DC or RMS continuous at 25°C environmental temperature.*

CABLE is 10 ft long, terminated with a locking BNC or UHF connector.

NET WEIGHT is approx 6 pounds, 5 ounces.

P6015 PROBE, order 010-0172-00 LOCKING BNC or 010-0132-00 UHF **$250**

Includes: compensating box (015-0049-00 BNC) or (015-0039-00 UHF); alligator clip (344-0005-00); probe holder (352-0056-00); can, dielectric (252-0120-00); silica-gel† (256-0570-00); carrying case (016-0128-00); instruction manual (070-0373-01).

†not shown.

OPTIONAL ACCESSORIES—see probe accessories at the rear of probe section.

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 100 kHz. At 10 MHz, the maximum allowable peak-to-peak voltage is 13 kV.

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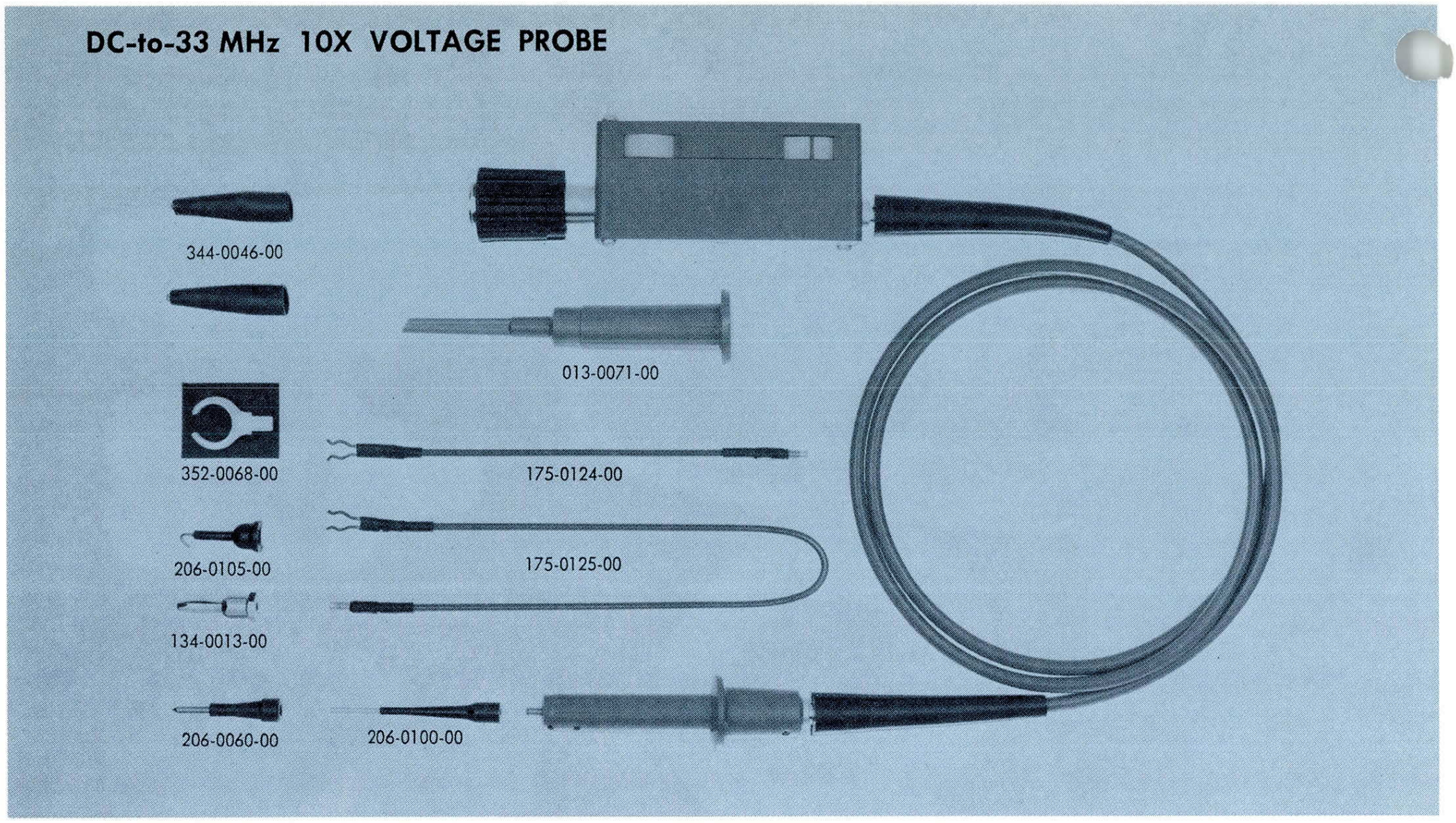
Please refer to Terms and Shipment, General Information p



The P6023 Low-Capacitance Probe is designed for use with Tektronix differential preamplifiers.

The probe can be adjusted to match plug-in input capacitance ranging from 20 pF to 50 pF. The 10X attenuation ratio is adjustable over a ±2.5% range to compensate for differences in the input resistance of the plug-in unit. When two P6023 probes are used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other helps to maintain the common-mode rejection ratio of the system.

ATTENUATION is 10X, adjustable ±2.5%.

INPUT RESISTANCE is approximately 8 megohms.

INPUT CAPACITANCE is approximately 12 pF when used with an instrument having a 20-pF or 47-pF input capacitance.

PROBE RISETIME is less than 7 ns.

TYPICAL RISETIME of probe, Type W Plug-In Unit, and Type 545B Oscilloscope is 17 ns.

VOLTAGE RATING is 1000 V DC or AC peak to peak.*

CABLE is 3.5 ft long, terminated with a locking BNC or U connector.

NET WEIGHT is approx 1 pound, 7 ounces.

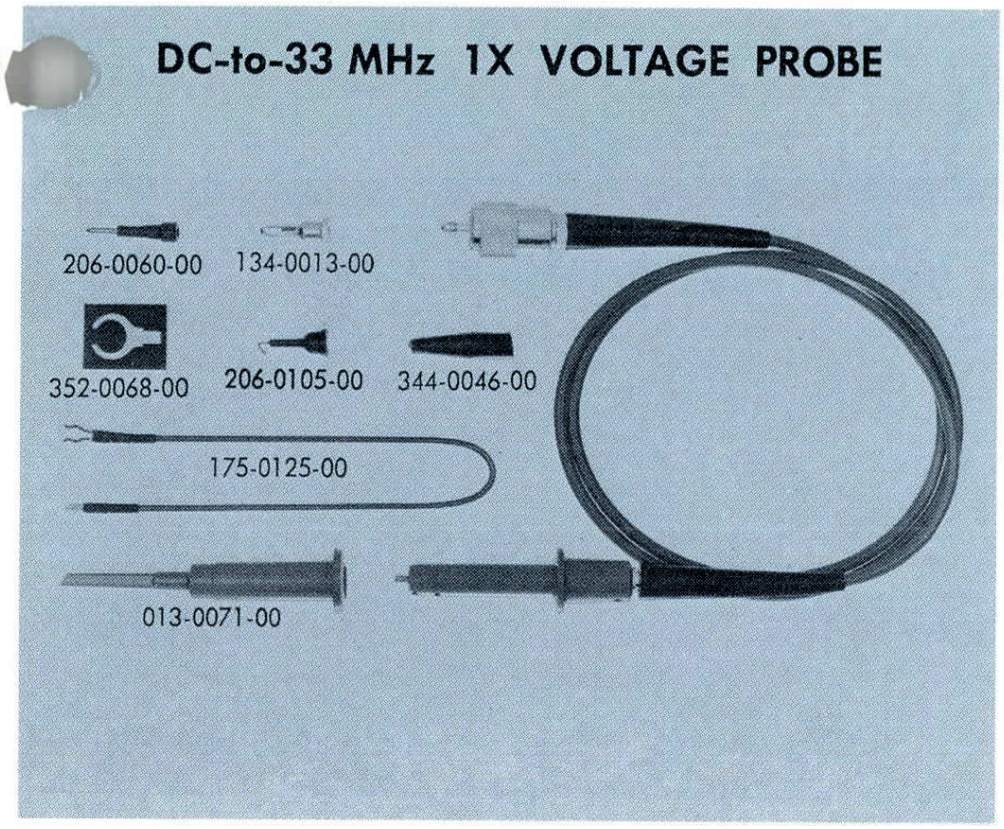
P6023 PROBE, order 010-0167-00 LOCKING BNC or 010-0065-00 UHF **$52**
Includes: spring tip (206-0060-00); hook tip (206-0105-00); retractable hook tip (013-0071-00); calibration tip (206-0100-00); banana plug (134-0013-00); two minigator clips (344-0046-00); probe holder (352-0068-00); 5-inch ground lead (175-0124-00); 12-inch ground lead (175-0125-00); instruction manual (070-0294-01).

OPTIONAL ACCESSORIES—see probe accessories at the rear of probe section.

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 5 MHz. At 20 MHz, the maximum allowable peak-to-peak voltage is 300 V.

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

P6027 Voltage Probes P6028



The P6027 is a general-purpose 1X voltage probe designed for use with Tektronix DC-to-33 MHz Oscilloscopes that have UHF input connectors.

In addition to the standard 3.5-ft cable length, the P6027 is available in cable lengths of 6 ft, 9 ft and 12 ft, at no additional cost. Insertion loss increases with probe cable length.

ATTENUATION is 1X.

INPUT RESISTANCE is 1 megohm, instrument input R included.

INPUT CAPACITANCE for standard length probe is approx 30 pF, 47 pF for the 6-ft version, 70 pF for the 9-ft version and 92 pF for the 12-ft version, instrument excluded. For total input capacitance of the system, add input C of instrument.

PROBE RISETIME is approximately 10 ns.

VOLTAGE RATING is 600 V DC or AC peak to peak.*

NET WEIGHT is approx 5 ounces.

STANDARD CABLE is 3.5 ft long, terminated with a UHF connector.

P6027 3.5-FT PROBE, order 010-0070-00 . . . . . **$16.50**

P6027 6-FT PROBE, order 010-0071-00 . . . . . **$16.50**

P6027 9-FT PROBE, order 010-0072-00 . . . . . **$16.50**

P6027 12-FT PROBE, order 010-0073-00 . . . . . **$16.50**

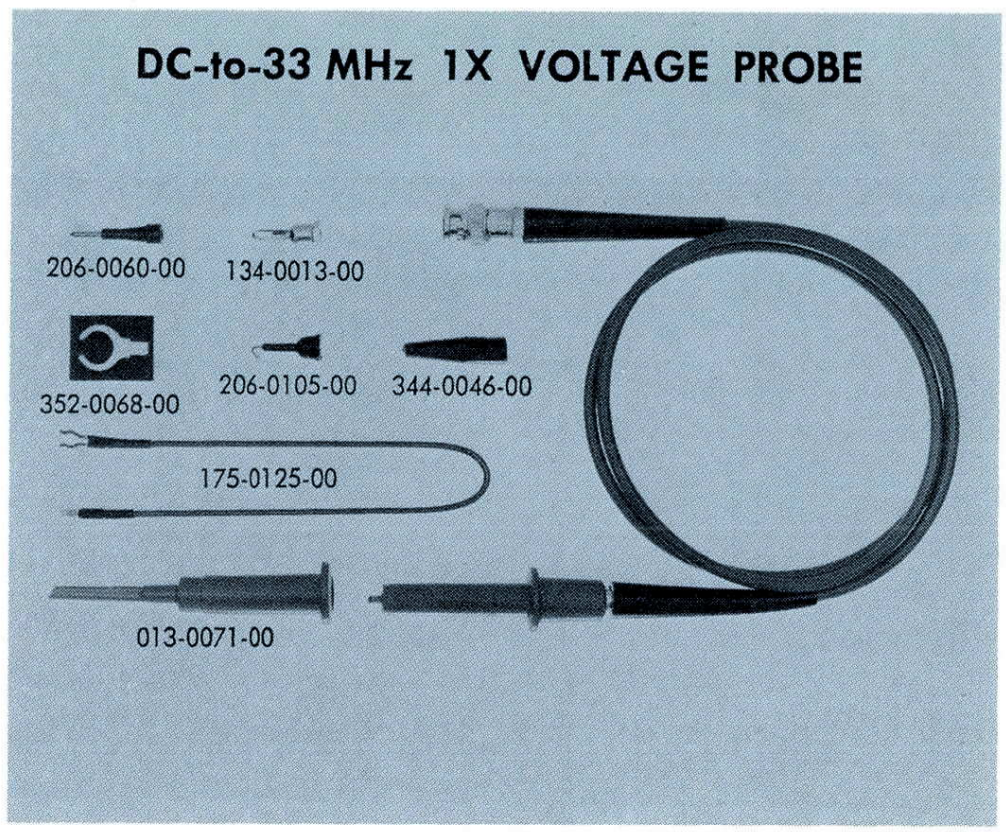
Includes: hook tip (206-0105-00); retractable hook tip (013-0071-00); spring tip (206-0060-00); banana plug (134-0013-00); minigator clip (344-0046-00); probe holder (352-0068-00); 12-inch ground lead (175-0125-00); parts list.

OPTIONAL ACCESSORIES—see probe accessories at the rear of probe section.

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 1 MHz. At 10 MHz, the maximum allowable peak-to-peak voltage is 60 V.

U.S. Sales Prices FOB Beaverton, Oregon

Please refer to Terms and Shipment, General Information page.



The P6028 is a general-purpose 1X voltage probe designed for use with Tektronix DC-to-33 MHz Oscilloscopes that have BNC input connectors.

In addition to the standard 3.5-ft cable length, the P6028 is available in cable lengths of 6 ft, 9 ft and 12 ft, at no additional cost. Insertion loss increases with probe cable length.

ATTENUATION is 1X.

INPUT RESISTANCE is 1 megohm, instrument input R included.

INPUT CAPACITANCE for standard length probe is approx 30 pF, 47 pF for the 6-ft version, 70 pF for the 9-ft version and 92 pF for the 12-ft version, instrument excluded. For total input capacitance of the system, add input C of instrument.

PROBE RISETIME is approximately 10 ns.

VOLTAGE RATING is 600 V DC or AC peak to peak.*

NET WEIGHT is approx 5 ounces.

STANDARD CABLE is 3.5 ft long, terminated with a BNC connector.

P6028 3.5-FT PROBE, order 010-0074-00 . . . . . **$16.50**

P6028 6-FT PROBE, order 010-0075-00 . . . . . **$16.50**

P6028 9-FT PROBE, order 010-0076-00 . . . . . **$16.50**

P6028 12-FT PROBE, order 010-0077-00 . . . . . **$16.50**

Includes: hook tip (206-0105-00); retractable hook tip (013-0071-00); spring tip (206-0060-00); banana plug (134-0013-00); minigator clip (344-0046-00); probe holder (352-0068-00); 12-inch ground lead (175-0125-00); parts list.

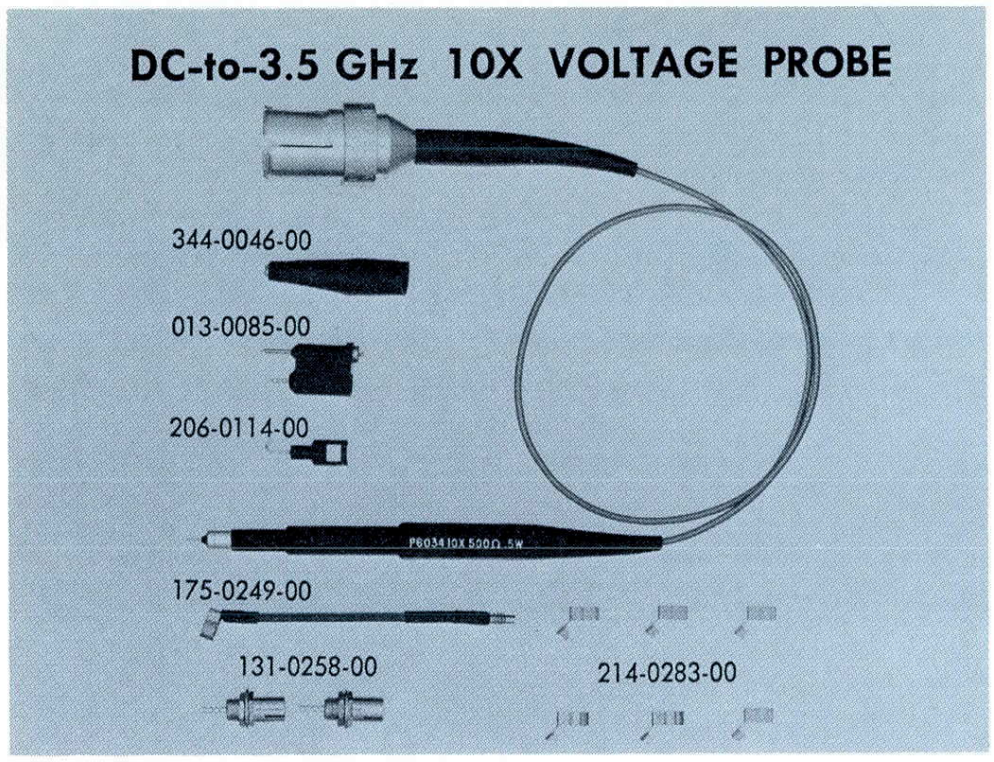
OPTIONAL ACCESSORIES—see probe accessories at the rear of probe section.

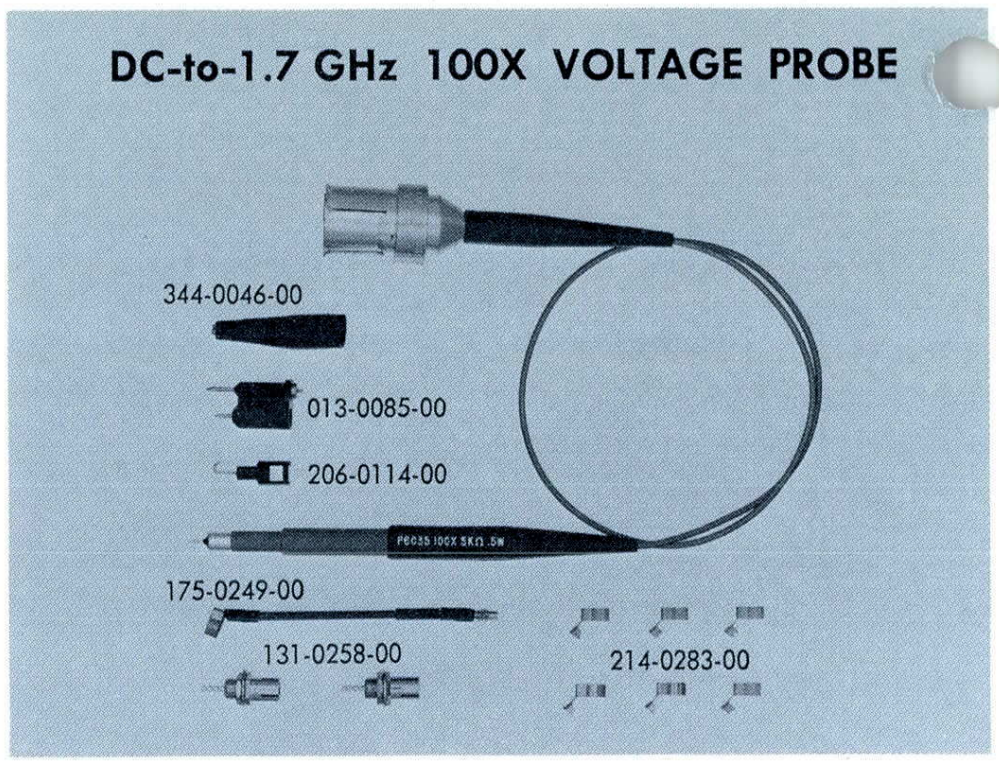
*Peak-to-peak voltage derating is necessary for CW frequencies higher than 1 MHz. At 10 MHz, the maximum allowable peak-to-peak voltage is 60 V.

U.S. Sales Prices FOB Beaverton, Oregon

Please refer to Terms and Shipment, General Information page.

P6034 Sampling Probes P6035





The P6034 and P6035 are low-capacitance miniature probes designed for use with Tektronix 50-Ω sampling units such as the Type 1S1, 1S2, 3S2/S-1 and 7S11/S-1 Sampling Plug-In Units. With the use of a 50-Ω termination, they can be used with wideband, non-sampling oscilloscopes when an extremely low input capacitance is required.

ATTENUATION is 10X.

INPUT RESISTANCE is 500 ohms ±1.5%, approximately 300 ohms at 1 GHz.

INPUT CAPACITANCE is 0.7 pF, DC to 1 GHz.

PROBE RISETIME is less than 100 ps.

BANDWIDTH is DC to 3.5 GHz (3-dB down).

MAXIMUM RINGING AND OVERSHOOT is 2% using a 25-ohm source and coaxial probe ground.

VOLTAGE RATING is 16 V DC or 45 V peak to peak.*

CABLE is 18 inches long with GR connector.

NET WEIGHT is approx 10 ounces.

P6034 PROBE, order 010-0110-00 . . . . . **$44**
Includes: hook tip (206-0114-00); six ground clips (214-0283-00); minigator clip (344-0046-00); two test jacks (131-0258-00); 2½-inch ground lead (175-0249-00); bayonet-ground adapter (013-0085-00); instruction manual (070-0368-00).

*Peak to peak voltage derating is necessary for CW frequencies higher than 800 MHz. At 1 GHz, the maximum allowable peak-to-peak voltage is 25 V.

ATTENUATION is 100X.

INPUT RESISTANCE is 5 kilohms ±1.5%, approximately 1.5 k at 1 GHz.

INPUT CAPACITANCE is 0.6 pF, DC to 1 GHz.

PROBE RISETIME is less than 200 ps.

BANDWIDTH is DC to 1.7 GHz (3-dB down).

MAXIMUM RINGING AND OVERSHOOT is 2% using a 25-ohm source and coaxial probe ground.

VOLTAGE RATING is 50 V DC or 140 V peak to peak.*

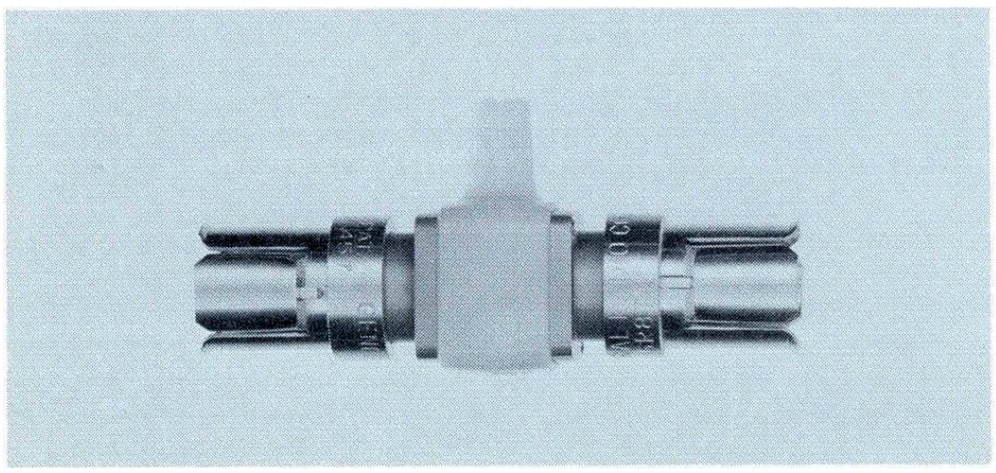
CABLE is 18 inches long with GR connector.

NET WEIGHT is approx 9 ounces.

P6035 PROBE, order 010-0111-00 . . . . . **$44**
Includes: hook tip (206-0114-00); six ground clips (214-0283-00); minigator clip (344-0046-00); two test jacks (131-0258-00); 2½-inch ground lead (175-0249-00); bayonet-ground adapter (013-0085-00); instruction manual (070-0369-00).

*Peak to peak voltage derating is necessary for CW frequencies higher than 500 MHz. At 1 GHz, the maximum allowable peak-to-peak voltage is 60 V.

OPTIONAL ACCESSORIES

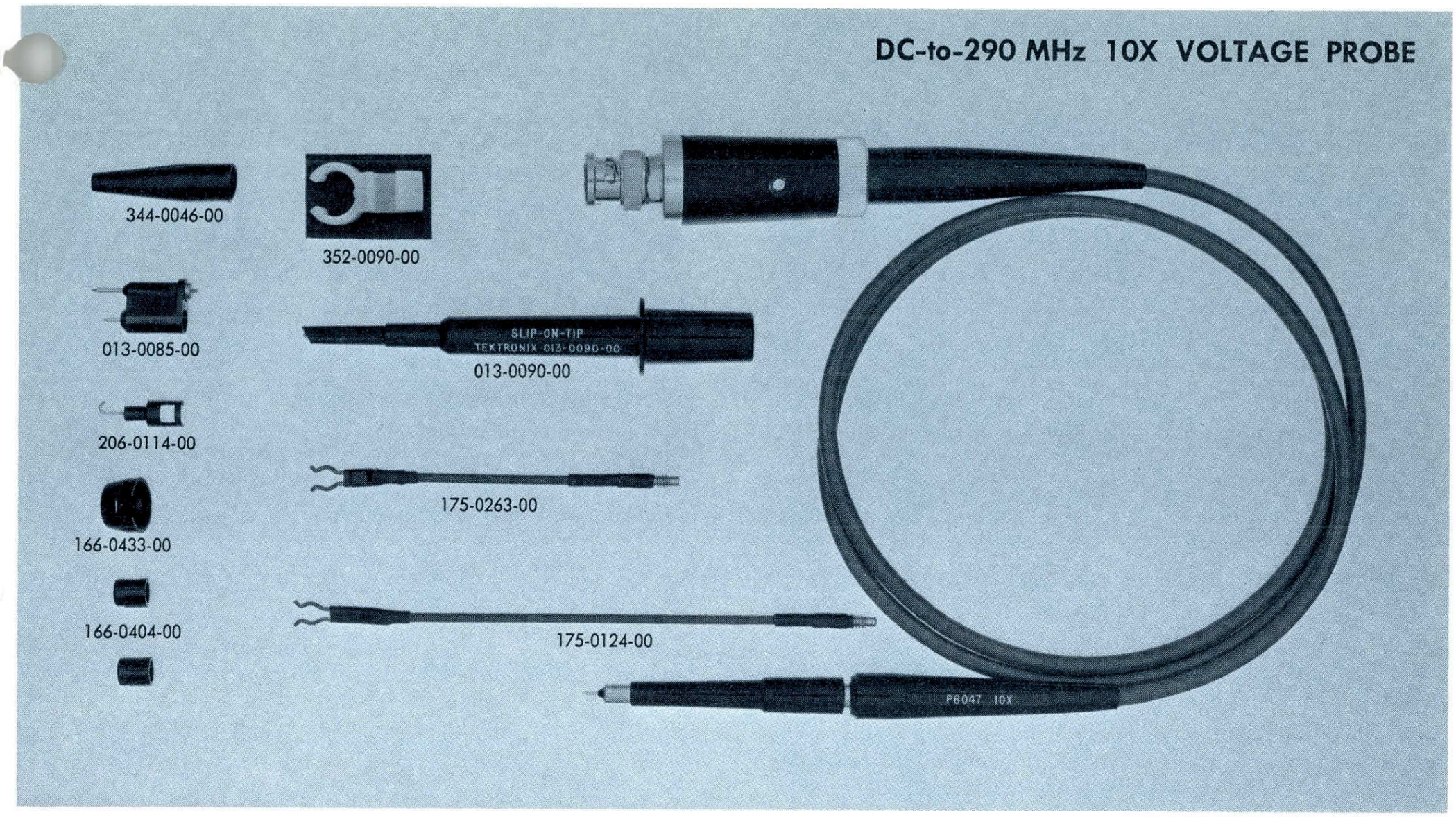


The VP-1 50-ohm "T" type pickoff allows signal pickoff from a closed 50-ohm system with minimum disturbance of the system's characteristics. The VP-1 is designed for use with the P6034 or P6035 Miniature Passive Probes. Using a Type 1S1 Sampling Plug-In Unit and a Type 281 Time-Domain Reflectometer Pulser having a system risetime of 0.75 ns, the reflection coefficient of the VP-1 is approximately 0.03. With the P6034 or P6035 inserted, it is typically 0.02. The resistive reflection of the VP-1 is 0.005 when used with the P6035, 0.05 when used with the P6034.

Order 017-0073-01 . . . . . $28.00

GR to BNC 50-Ω thru-line termination, order 017-0083-00 $31.00
Probe Tip to GR Adapter, order 017-0076-00 . . . . . 8.30
Probe Tip to BNC Adapter, order 013-0084-01 5
Coupling Capacitor, GR 874-K, order 017-0028-00 . . . . 12.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.



The P6047 is a general-purpose probe designed for use with the Type 454 Portable Oscilloscope or the Type 647A Oscilloscope with Type 10A2A Plug-In Unit. It can also be compensated for use with other instruments that have an input capacitance of 15 to 20 pF, and input resistance of 1 MΩ.

The P6047 offers a new level of performance in passive probe design. Its small size makes it easy to use, particularly for applications involving compact circuitry. In addition to the standard 3.5-foot cable length, the probe is available with a 6-foot cable at no additional cost.

ATTENUATION is 10X.

INPUT RESISTANCE is 10 megohms.

INPUT CAPACITANCE for the standard length probe is 10.3 pF or less when used with instrument having a 15-to-20 pF input capacitance; 12 pF for the 6-foot version. The input capacitance of both probes decreases to less than 7 pF above 100 MHz.

PROBE RISETIME is 1.2 ns† or less.

TYPICAL RISETIME of probe and Type 454 Oscilloscope is 2.4 ns†. Typical risetime with Type 10A2A is 3.5 ns†.

ABERRATIONS are 3% or less.

VOLTAGE RATING is 500 V DC, AC peak, or DC and AC peak combined.*

STANDARD CABLE is 3.5 ft long, terminated with a BNC connector.

NET WEIGHT is approx 12 ounces.

P6047 3.5-FT PROBE, order 010-0211-00 . . . . . **$50**

P6047 6-FT PROBE, order 010-0217-00 . . . . . **$50**

Includes: hook tip (206-0114-00); retractable-hook tip (013-0090-00); bayonet-ground adapter (013-0085-00); minigator clip (344-0046-00); probe holder (352-0090-00); 3-inch ground lead (175-0263-00; 5-inch ground lead (175-0124-00); two insulating tubes (166-0404-00); insulating sleeve (166-0433-00); instruction manual (070-0628-01).

OPTIONAL ACCESSORIES

Prope Tip to GR Adapter, order 017-0076-00 . . . . . $ 8.30

Prope Tip to BNC Adapter, order 013-0084-01 . . . . . $ 5.30

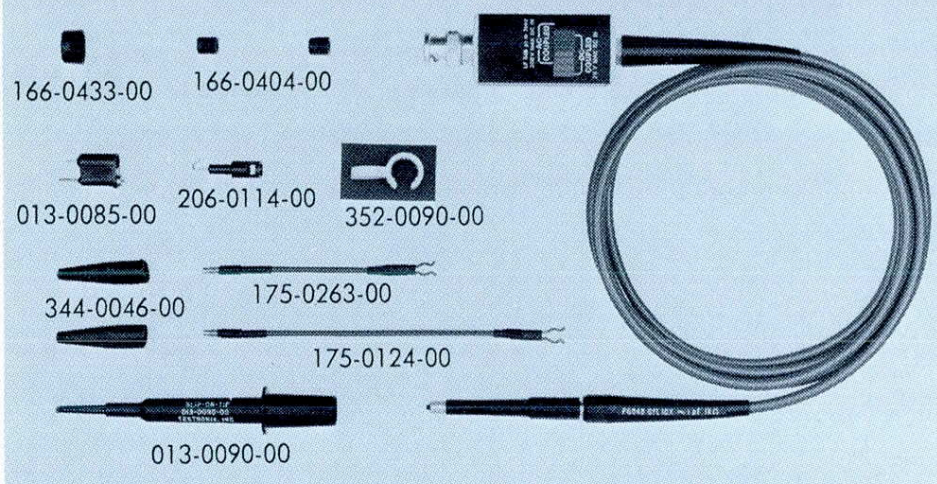
†Due to the fast-rise characteristics of this probe, the input capacitance and generator source impedance must be considered in determining the risetime of the system. Risetimes listed are at a temperature of 25° C.

*Peak voltage derating is necessary for CW frequencies higher than 4.5 MHz. At 10 MHz, the maximum allowable peak voltage is 200 V; 23 V at 100 MHz, 18 V at 150 MHz.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

P6048 Voltage Probes P6049

DC-to-140 MHz 10X VOLTAGE PROBE



The P6048 is a low-capacitance, miniature probe designed for use with Tektronix high-frequency oscilloscopes such as the Type 454 and Type 647A. It can also be compensated for use with other instruments that have an input capacitance of 14 to 21 pF and input resistance of 1 MΩ.

The P6048 offers a new level of high-frequency measurement performance with its low 1-pF input capacitance. Its small size makes it easy to use, particularly for applications involving compact circuitry.

ATTENUATION is 10X.

INPUT RESISTANCE is 1 kΩ.

INPUT CAPACITANCE is 1 pF or less.

BANDWIDTH/RISETIME when used with Type 454 Oscilloscope.

Oscilloscope Deflection Factor	Minimum Bandwidth	Maximum Risetime
5 mV/div	45 MHz	7.8 ns
10 mV/div	75 MHz	4.7 ns
20 mV/div to 10 V/div	100 MHz	3.5 ns
AC-coupled low-frequency response is 7 kHz or less.		

ABERRATIONS are +3%, —3% or less; total of 5% P-P or less.

VOLTAGE RATING DC coupled is 20 V (DC plus peak AC); AC coupled is 200 V DC.

STANDARD CABLE is 6 ft long, terminated with a BNC connector.

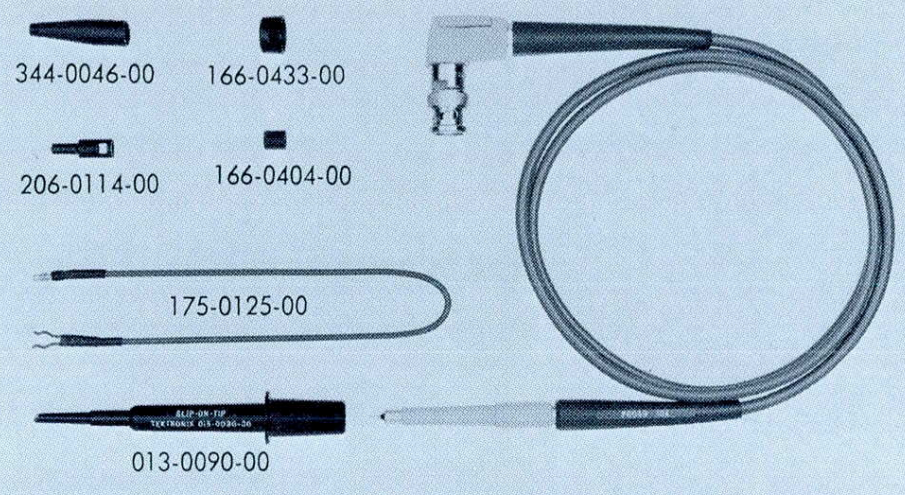
NET WEIGHT is approx 13 ounces.

P6048 PROBE, order 010-0215-00 . . . . . **$61**
Includes: hook tip (206-0114-00); retractable-hook tip (013-0090-00); 3-inch ground lead (175-0263-00); 5-inch ground lead (175-0124-00); 2 minigater clips (344-0046-00); bayonet-ground adapter (013-0085-00); 2 insulator tubes (166-0404-00); probe holder (352-0090-00); ground insulator (166-0433-00); hook-tip handle (367-0105-00, not shown); instruction manual (070-0675-00).

OPTIONAL ACCESSORIES

Probe Tip to GR Adapter, order 017-0076-00 . . . . . $ 8.30
Probe Tip to BNC Adapter, order 013-0084-01 . . . . . $ 5.30

DC-to-21 MHz 10X VOLTAGE PROBE



The P6049 is a miniature passive probe designed for use with the Sony/Tektronix Type 323 portable oscilloscope. The probe is easily compensated for use with any instrument having an input capacitance of 43 pF to 66 pF and an input resistance of 1 MΩ.

The small P6049 is easy to use, particularly for applications involving compact circuitry. The probe has a 3.5-foot cable and a right-angle BNC connector.

ATTENUATION is 10X.

INPUT RESISTANCE is 10 megohms.

INPUT CAPACITANCE is 13.5 pF or less.

PROBE RISETIME is 17 ns or less.

ABERRATIONS are within +1.5% or —1.5%, total of 2% P-P or less.

VOLTAGE RATING is 500 V (DC plus peak AC)*.

STANDARD CABLE is 3.5 feet long, terminated with a right angle BNC connector.

NET WEIGHT is approx 11 ounces.

P6049 PROBE, order 010-0223-00 . . . . . **$36**
Includes: hook tip (206-0114-00); retractable-hook tip (013-0090-00); minigator clip (344-0046-00); 12-inch ground lead (175-0125-00); insulating tube (166-0404-00); hook-tip handle (367-0105-00, not shown); ground insulator (166-0433-00); instruction manual (070-0746-00).

OPTIONAL ACCESSORY

Probe Tip to BNC Adapter, order 013-0084-01 . . . . . $ 5.30

*Peak voltage derating is necessary for CW frequencies higher than 4 MHz. At 10 MHz, the maximum allowable CW peak voltage is 190 V.

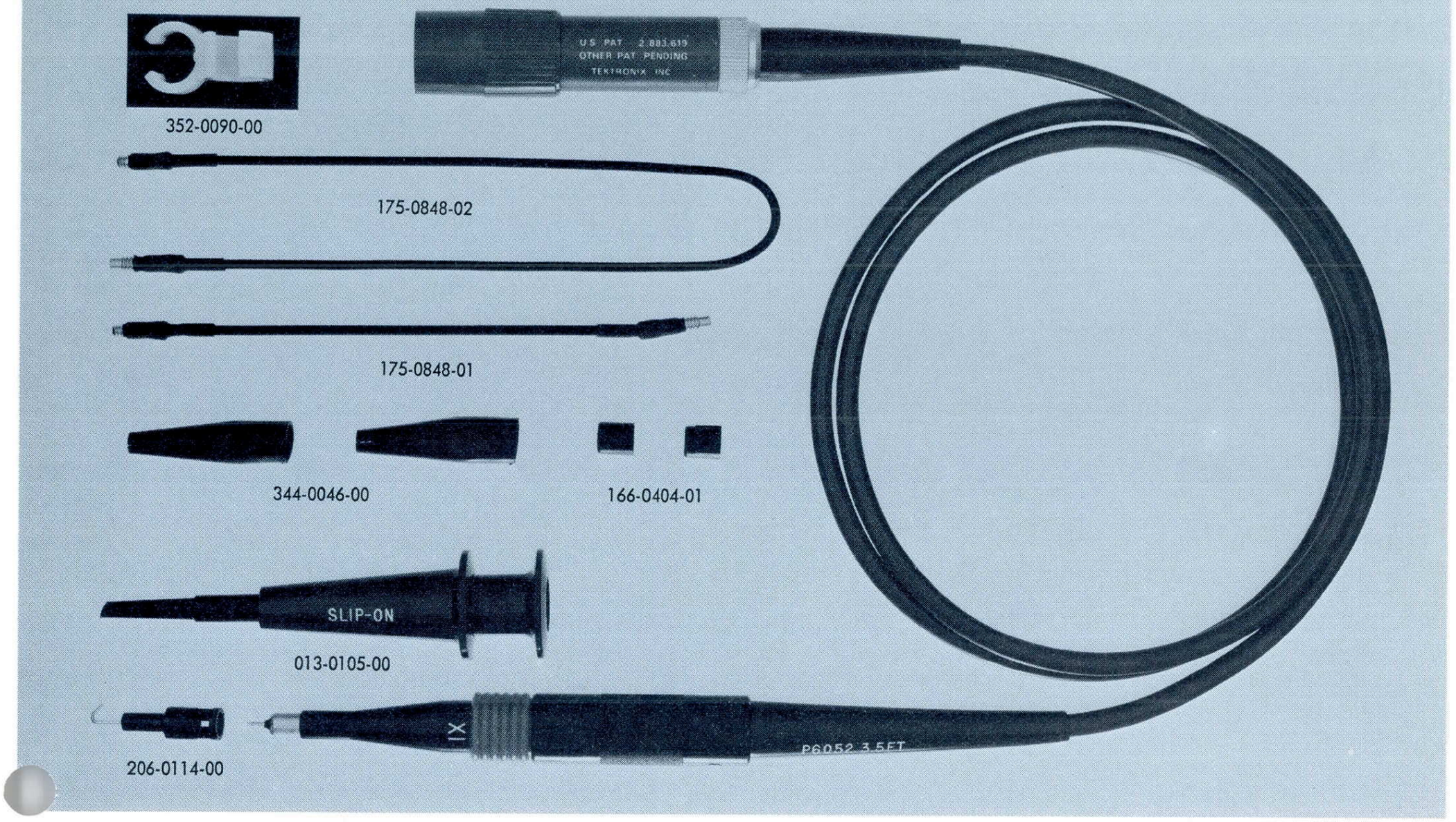
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

NEW

P6052 Voltage Probe

P6052

DC-to-44 MHz 1X, 10X SELECTABLE ATTENUATION PROBE



The P6052 is a passive dual-attenuation probe designed for Tektronix low-frequency oscilloscopes that feature scale factor readout and trace-identification functions. A sliding collar on the barrel of the probe selects 1X or 10X attenuation; a push button actuates the trace-identify function. A coding ring on the probe BNC output connector couples the control signals to the main frame. The P6052 can be compensated for use with instruments having an input capacitance of 15 to 55 pF.

ATTENUATION is 1X within 2%, 10X within 3%.

INPUT RESISTANCE: 1X position, 1 megohm within 2%; 10X position, 10 megohms within 1.5%.

INPUT CAPACITANCE for the 3.5-foot probe is 105 pF in the 1X position, 13.5 pF within 1 pF in the 10X position. For the six-foot version the input capacitance in the 1X position is 134 pF within 6 pF, the 10X position 16 pF within 1 pF.

PROBE RISETIME for the 3.5-foot probe is $\leq$60 ns in the 1X position, $\leq$8 ns in the 10X position. For the six-foot version: 1X position $\leq$75 ns, 10X position $\leq$11 ns.

VOLTAGE RATING is 500 V (DC + Peak AC)*.

PROBE CABLE is terminated with a BNC connector having a coding ring.

NET WEIGHT is approx 1 pound.

P6052 3.5-FT PROBE, order 010-0241-00 . . . . . **$55**

P6052 6-FT PROBE, order 010-0243-00 . . . . . **$55**
Includes: retractable hook tip, (013-0105-00); hook tip, (206-0114-00); 5-inch ground lead, (175-0848-01); 12-inch ground lead, (175-0848-02); two minigator clips, (344-0046-00); two insulating tubes, (166-0404-01); probe holder, (352-0090-00); instruction manual, (070-0973-00).

*Peak voltage derating is necessary for CW frequencies higher than 600 kHz in the 1X position and above 5 MHz in the 10X position. At 44 MHz the maximum allowable peak voltage is approximately 5 V in the 1X position and aproximately 50 V in the 10X position.

U.S. Sales Prices F.O.B Beaverton, Oregon
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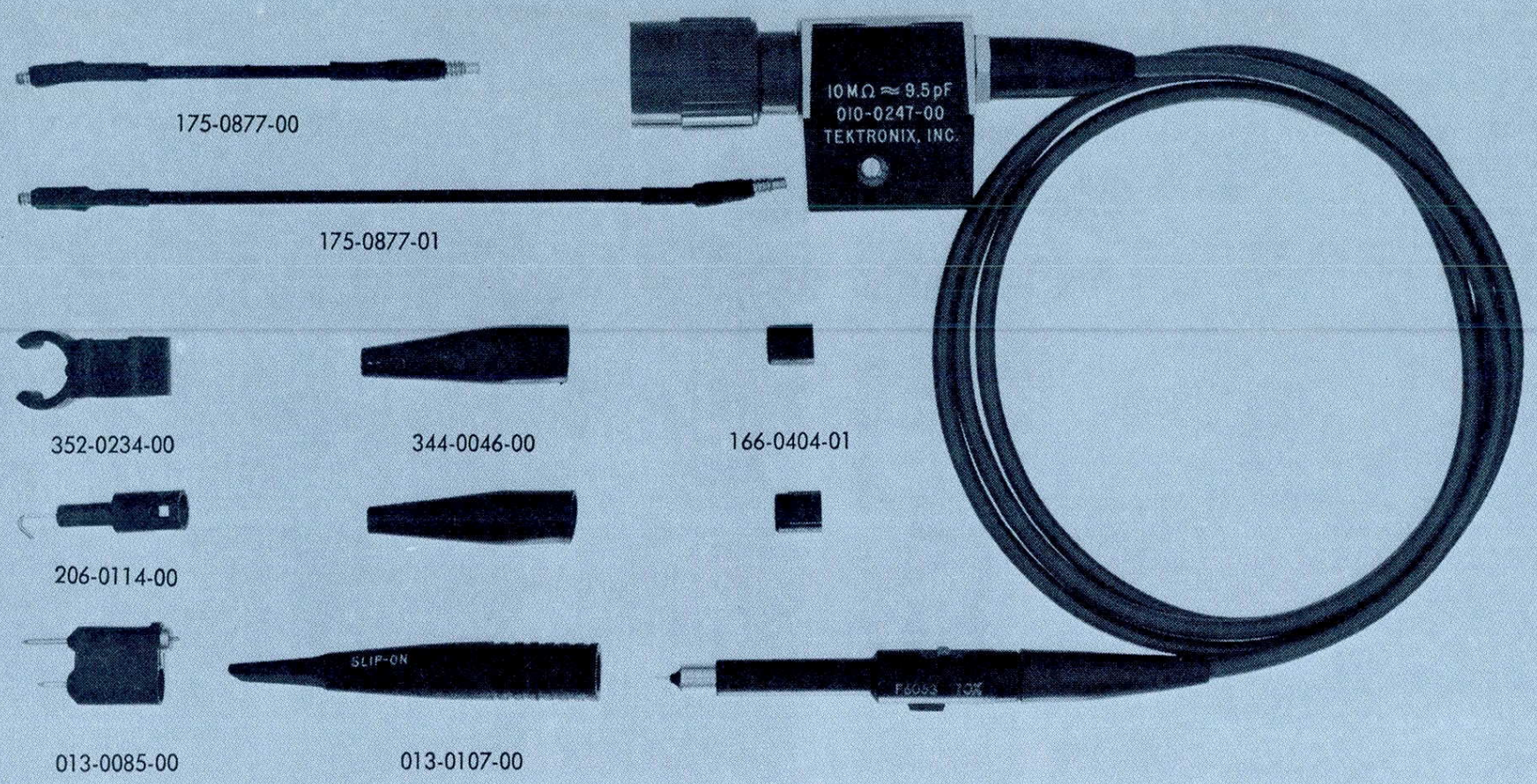
NEW

P6053 Voltage Probe P605

DC-to-500 MHz 10X VOLTAGE PROBE



The P6053 is a miniature fast-rise 10X probe designed primarily for Tektronix 7-Series vertical plug-in units. The probe can be compensated for use with all oscilloscopes or vertical units having an input capacitance of 15 to 24 pF. The probe has a push button for actuating the trace-identify function of the oscilloscope main frame.

ATTENUATION is 10X within 3%.

INPUT RESISTANCE is 10 megohms within 1.5%.

INPUT CAPACITANCE for the 3.5-foot probe is 9.5 pF within 0.5 pF; 12 pF within 0.5 pF for the six-foot version.

PROBE RISETIME is 0.7 ns† or less.

VOLTAGE RATING is 500 V (DC + Peak AC).*

PROBE CABLE is terminated with a BNC connector having a coding ring.

NET WEIGHT is approx 1 pound.

P6053 3.5-FT PROBE, order 010-0248-00 ..... **$55**
P6053 6-FT PROBE, order 010-0250-00 ..... **$55**

Includes: hook tip (206-0114-00); retractable-hook tip (013-0107-00); bayonet-ground adapter (013-0085-00); minigator clip (344-0046-00); probe holder (352-0234-00); 3-inch ground lead (175-0877-00); 5-inch ground lead (175-0877-01); two insulating tubes (166-0404-01); instruction manual (070-1001-00).

OPTIONAL ACCESSORIES

Probe Tip to GR Adapter, order 017-0076-00 ..... $ 8.30
Probe Tip to BNC Adapter, order 013-0084-01 ..... $ 5.30

†Due to the fast-rise characteristics of this probe, the input capacitance and generator source impedance must be considered in determining the risetime of the system. Risetimes listed are at a temperature of 25°C.

*Peak voltage derating is necessary for CW frequencies higher than 4.5 MHz. At 10 MHz, the maximum allowable peak voltage is 200 V; 23 V at 100 MHz, 18 V at 150 MHz.

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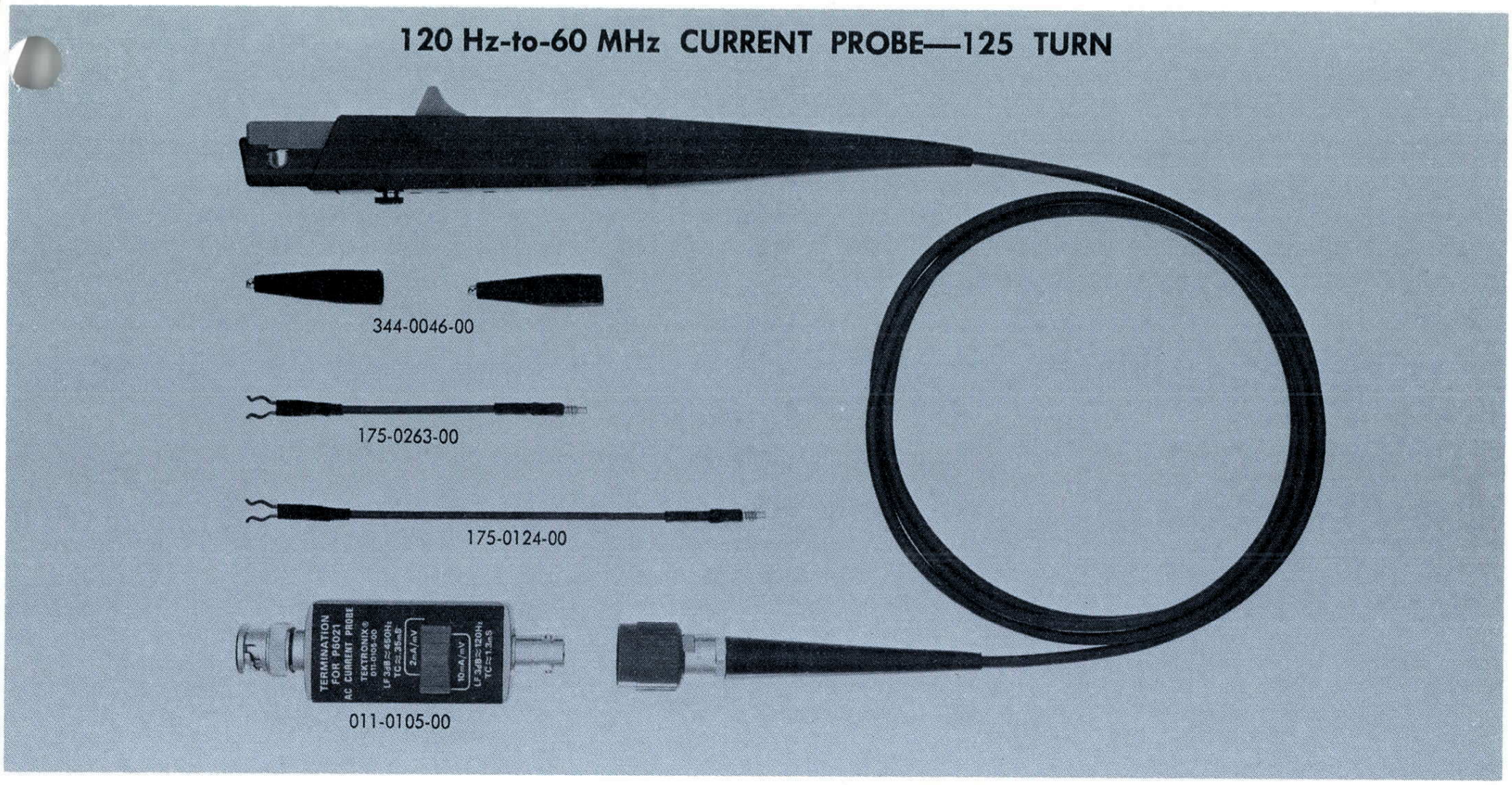
Please refer to Terms and Shipment, General Information page.

AC Current Probe

P6021



The P6021 is a 125-Turn AC Current Probe, with passive termination or Type 134 Amplifier, designed for use with Tektronix real-time oscilloscopes. Neither the termination nor the amplifier are required to use the probe with the Type 5030 and 5031 Oscilloscopes, 3A9 and 7A14 plug-in units. The P6021 provides the facility for accurate current measurements over a wide range of frequencies without breaking the circuit under test. Simply open the spring-loaded slide, place the conductor* in the probe slot, and release the slide . . . no electrical connection required.

The shielded probe head is not grounded when the slide is in the open position, eliminating accidental grounding of the circuit under test. For general-purpose applications, the P6021 offers wide-band performance with excellent low-frequency characteristics. The probe's low-frequency capabilities and sensitivity can be expanded using the Type 134 Current Probe Amplifier. The P6021, with passive termination or with the amplifier, can be used with oscilloscopes having input resistances of 1-megohm or greater. Please turn to page 417 for ordering information.

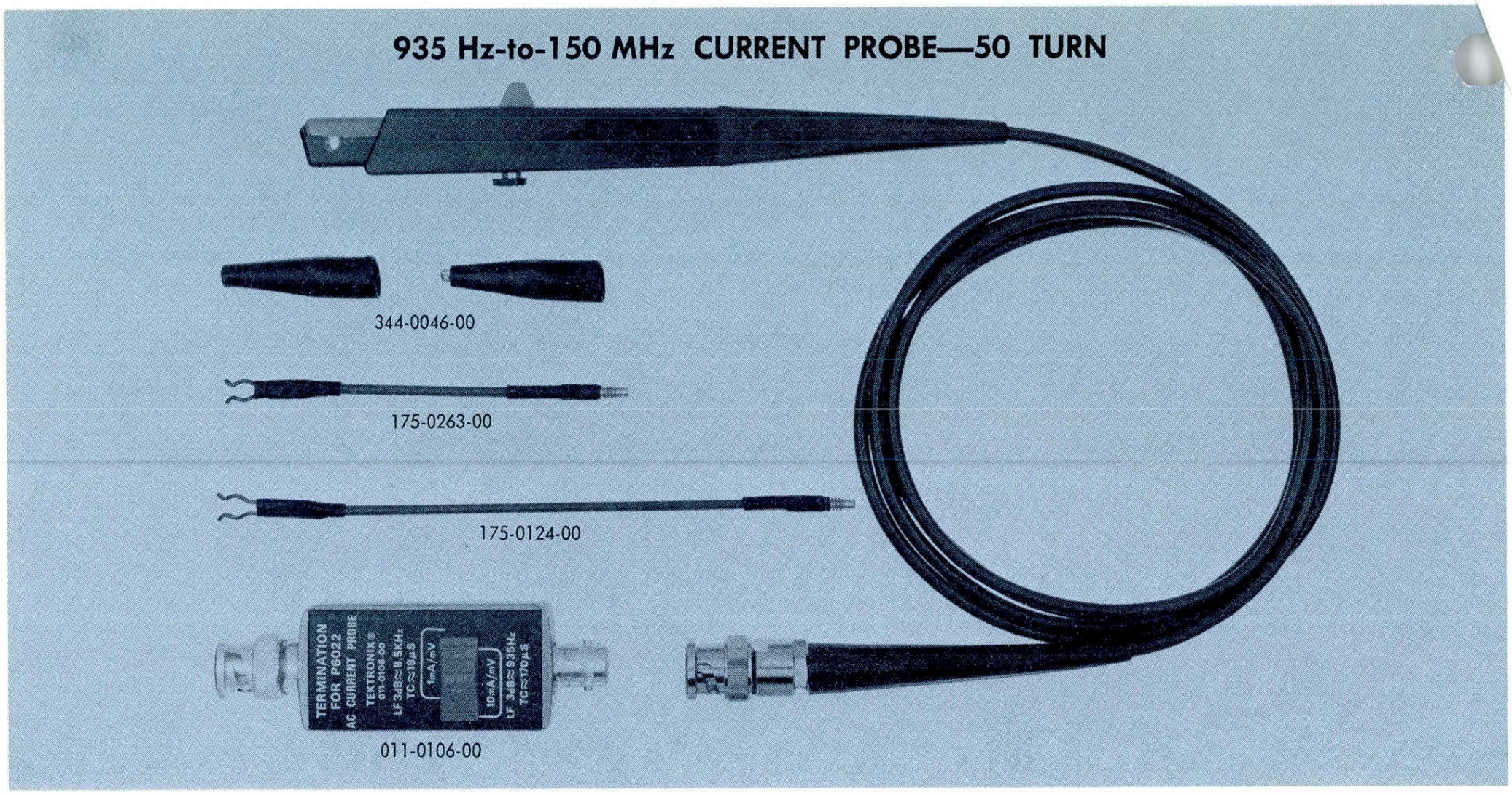
PERFORMANCE CHARACTERISTICS

	P6021 PROBE WITH PASSIVE TERMINATION	P6021 PROBE WITH TYPE 134 AMPLIFIER
SENSITIVITY	2 mA/mV or 10 mA/mV; selected by termination switch. Accuracy ±3%.	Switched current amplifier steps from 1 mA/div to 1 A/div (with 50 mV/div oscilloscope setting). Accuracy ±3%.
SYSTEM BANDWIDTH†/RISETIME Oscilloscope Bandwidth 50 MHz 75 MHz 100 MHz	Bandwidth / Risetime 39 MHz / 9.0 ns 48 MHz / 7.3 ns 52 MHz / 6.7 ns	Bandwidth / Risetime 30 MHz / 11.6 ns 35 MHz / 10.0 ns 36 MHz / 9.6 ns
LOW-FREQUENCY RESPONSE	≤450 Hz at 2 mA/mV ≤120 Hz at 10 mA/mV	≤12 Hz
NOISE		≤150 μA
MAXIMUM CURRENT	15 A Peak to Peak between 1.2 kHz and 5 MHz at 2 mA/mV, and between 300 Hz and 5 MHz at 10 mA/mV	
MAXIMUM VOLTAGE	600 V (DC + peak AC)	600 V (DC + peak AC)
PRICE	$121	$325

*Up to 0.150-inch diameter.

†All bandwidths stated are at —3 dB.

AC Current Probe



The P6022 is a 50-Turn AC Current Probe, with passive termination or Type 134 Amplifier, designed for use with Tektronix real-time oscilloscopes. The termination or amplifier are not required to use the probe with the Type 7A14 plug-in unit. The P6022 provides the facility for accurate current measurements over a wide range of frequencies without breaking the circuit under test. Simply open the spring-loaded slide, place the conductor* in the probe slot, and release the slide . . . no electrical connection required.

The shielded probe head is not grounded when the slide is in the open position, eliminating accidental grounding of the circuit under test. The extra-small size of the P6022 makes it ideally suited for measuring current in compact semiconductor circuits. The probe's low-frequency capabilities and sensitivity can be expanded using the Type 134 Current Probe Amplifier. The P6022, with passive termination or with the amplifier, can be used with oscilloscopes having input resistances of 1-megohm or greater.

PERFORMANCE CHARACTERISTICS

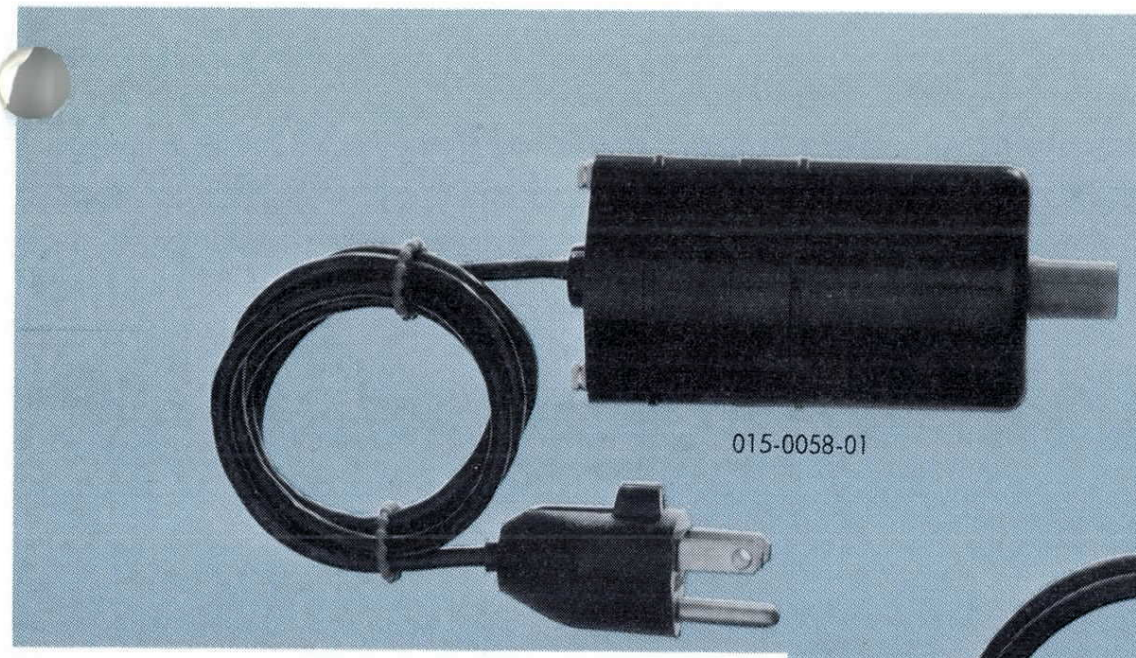
	P6022 PROBE WITH PASSIVE TERMINATION				P6022 PROBE WITH TYPE 134 AMPLIFIER	
SENSITIVITY	1 mA/mV or 10 mA/mV, selected by termination switch. Accuracy ±3%.				Switched current amplifier steps from 1 mA/div to 1 A/div (with 50 mV/div oscilloscope setting). Accuracy ±3%.	
SYSTEM BANDWIDTH†/RISETIME Oscilloscope Bandwidth	Bandwidth 1 mA/mV	 10 mA/mV	Risetime 1 mA/mV	 10 mA/mV	Bandwidth	Risetime
50 MHz	47 MHz	48 MHz	7.45 ns	7.2 ns	40 MHz	8.8 ns
75 MHz	65 MHz	70 MHz	5.35 ns	5.0 ns	50 MHz	7.0 ns
100 MHz	80 MHz	90 MHz	4.36 ns	3.9 ns	54 MHz	6.4 ns
150 MHz	100 MHz	120 MHz	3.50 ns	2.9 ns	59 MHz	5.9 ns
LOW FREQUENCY RESPONSE	≤8.5 kHz at 1 mA/mV ≤935 Hz at 10 mA/mV				≤100 Hz	
NOISE					≤150 μA	
MAXIMUM CURRENT	6 A Peak to Peak between 10 kHz and 10 MHz at 1 mA/mV, and between 3 kHz and 10 MHz at 10 mA/mV					
MAXIMUM VOLTAGE	600 V (DC + peak AC)				600 V (DC + peak AC)	
PRICE	$165				$360	

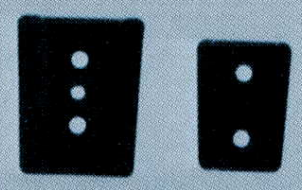
*Up to 0.100-inch diameter.

†All bandwidths stated are at —3 dB.

Current Probe Amplifier

134


015-0058-01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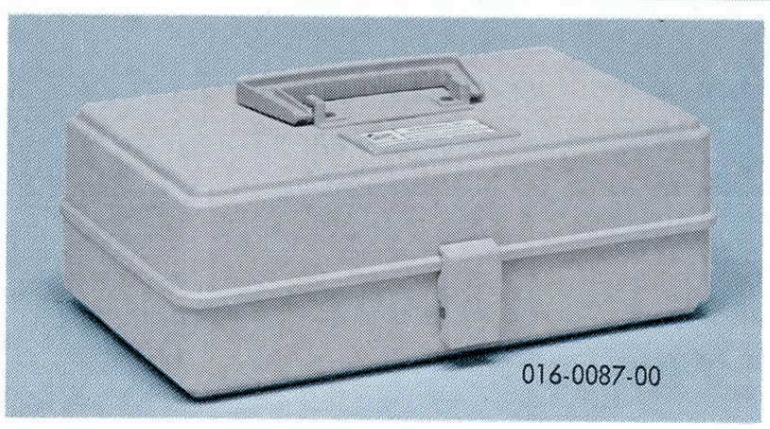
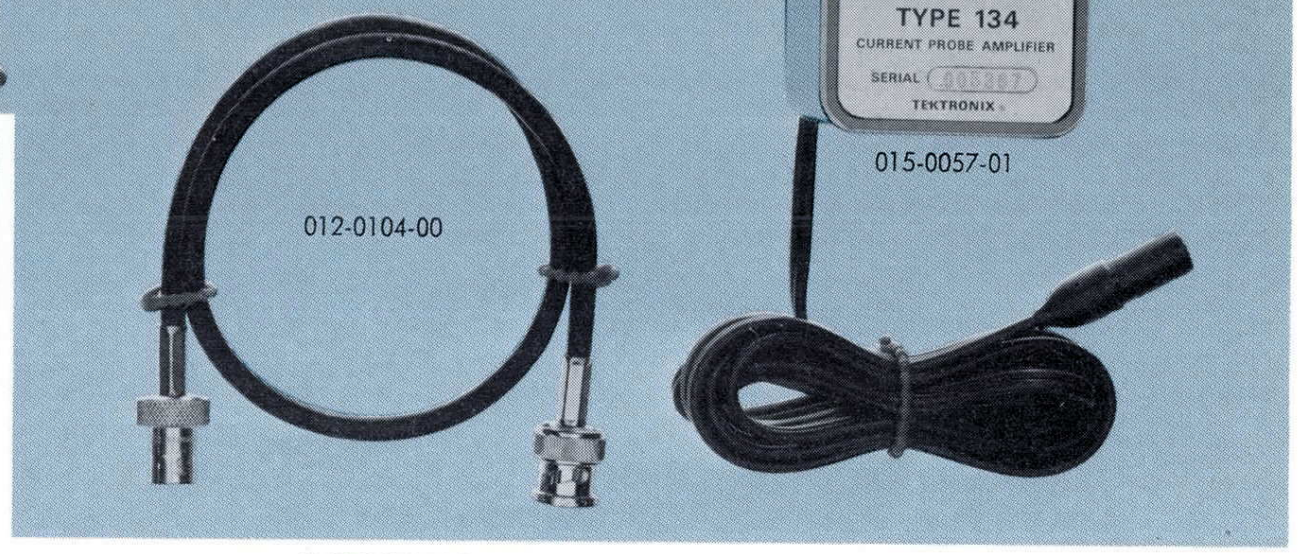
015-0057-01


016-0087-00



The Type 134 is used to extend the measurement capabilities of the P6021 or P6022 Current Probe. An INPUT switch on the front panel of the amplifier establishes the appropriate gain setting for the probe in use. A CURRENT/DIV switch provides calibrated current steps from 1 mA/div to 1 A/div (with the oscilloscope or plug-in unit adjusted for a deflection factor of 50 mV/div).

The Type 134 can also be used as an auxiliary voltage amplifier by placing the current/div switch in the VOLTS position.

DEFLECTION FACTOR: (with 50 mV/div oscilloscope input setting) 1 mV/div or 0.4 mV/div.

GAIN: 50 or 125, ±3%. Selected by lever switch.

IMPEDANCE: (input and output) approx 50 Ω, AC-coupled.

BANDWIDTH: 8 Hz to 54 MHz at a gain of 50; 10 Hz to 30 MHz at a gain of 125 (3-dB down).

TYPE 134 AMPLIFIER ONLY (015-0057-01) $209
POWER SUPPLY ONLY, 115 V (015-0058-01) ..... $ 33
POWER SUPPLY ONLY, 230 V (015-0059-01) ..... $ 33

ORDERING INFORMATION

P6021

P6021 5-FT PROBE WITH PASSIVE TERMINATION (015-0140-02) $121
P6021 9-FT PROBE WITH PASSIVE TERMINATION (015-0140-03) $121
P6021 5-FT PROBE (010-0237-02) ..... $ 94
P6021 9-FT PROBE (010-0244-02) ..... $ 94
Probe includes: 5-inch ground lead (175-0124-00); 3-inch ground lead (175-0263-00); two alligator clips (344-0046-00); instruction manual (070-0947-00).
P6021 PASSIVE TERMINATION (011-0105-00) ..... $ 33
P6021 PROBE, TYPE 134 AMPLIFIER WITH 115-V POWER SUPPLY (015-0141-01) $325
P6021 PROBE, TYPE 134 AMPLIFIER WITH 230-V POWER SUPPLY (015-0142-01) $325
Probe/amplifier includes: hanger assembly (014-0029-00); cable, coax, 18 inches (012-0104-00); carrying case (016-0087-00); 5-inch ground lead (175-0124-00); 3-inch ground lead (175-0263-00) two alligator clips (344-0046-00); two instruction manuals (070-0947-00).

P6022

P6022 5-FT PROBE WITH PASSIVE TERMINATION (015-0135-00) $165
P6022 PROBE (010-0238-00) $127
Probe includes: 5-inch ground lead (175-0124-00); 3-inch ground lead (175-0263-00); two alligator clips (344-0046-00); instruction manual (070-0948-00).
P6022 PASSIVE TERMINATION (011-0106-00) ..... $ 44
P6022 PROBE, TYPE 134 AMPLIFIER WITH 115-V POWER SUPPLY (015-0136-00) $360
P6022 PROBE, TYPE 134 AMPLIFIER WITH 230-V POWER SUPPLY (015-0137-00) $360
Probe/amplifier includes: hanger assembly (014-0029-00); cable, coax, 18 inches (012-0104-00); carrying case (016-0087-00); 5-inch ground lead (175-0124-00); 3-inch ground lead (175-0263-00); two alligator clips (344-0046-00); two instruction manuals (070-0948-00).

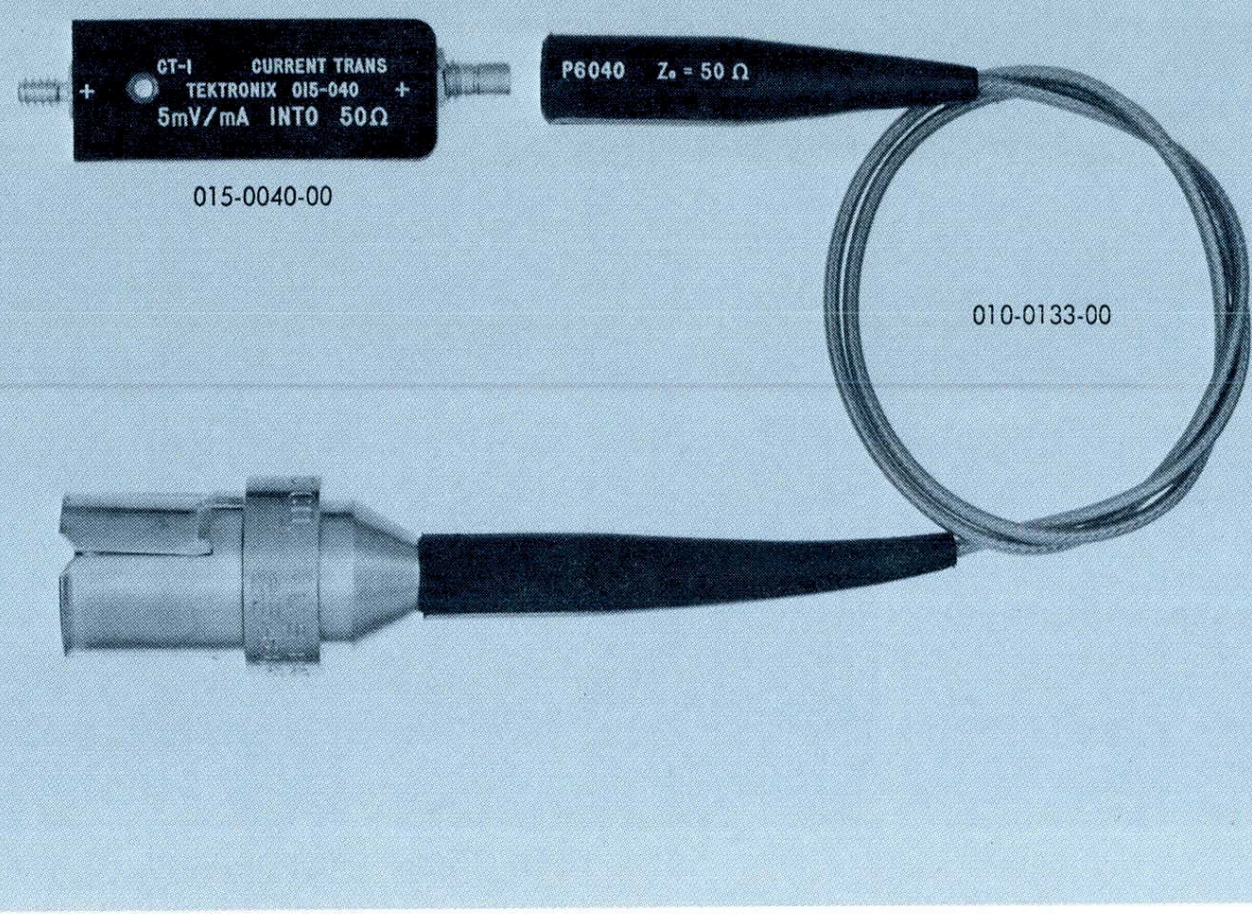
OPTIONAL ACCESSORIES

CALIBRATOR ADAPTER, BNC (013-0092-00) $5.00
ADAPTER, BNC to UHF (103-0015-00) $1.80

U. S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information Page

P6040/CT-1 AC Current Probe

35 kHz-to-1 GHz



015-0040-00

010-0133-00

The P6040/CT-1 Current Probe is designed for use with Tektronix 50-Ω sampling units, such as the Type 1S1, 1S2, 3S1, 3S2, 3S5, 3S6 and 7S11 Sampling Plug-In Units. With the use of a 50-Ω termination the P6040/CT-1 can be used with wide-band, non-sampling oscilloscopes for making fast-risetime current measurements.

Several CT-1 current transformers may be placed throughout the circuit and monitored by one or more P6040 Probes. For a longer length probe, additional 50-Ω cable can be used in series with the probe.

P6040 PROBE

The P6040 Probe is an inter-connecting cable for the CT-1, used between the transformer and oscilloscope input.

If several CT-1 Transformers are in a circuit, the P6040 Probe can be used to monitor any one of them.

The P6040 can be used with other test-point connectors, such as Amphenol series 27 Sub-Minax or Sealectro Sub-Miniature RF.

IMPEDANCE is 50 ohms.

ATTENUATION is 1X.

OUTPUT CONNECTOR is a GR type.

CABLE LENGTH is 18 inches. Additional 50-Ω cable can be used in series with the probe. RG8/U or RG58A/U is recommended for best preservation of the CT-1 Transformer high-frequency response.

CT-1 CURRENT TRANSFORMER

SENSITIVITY is 5 mV/mA into a 50-ohm load. Accuracy is better than ±3%.

DECAY TIME CONSTANT is 5 μs, approximated by 1% per 50 ns; limit, 1 μs.

RISETIME is less than 350 ps.

FREQUENCY RESPONSE is 35 kHz to 1 GHz (30% d[illegible] points).

INSERTION IMPEDANCE with a 50-ohm termination is 1 ohm shunted by approximately 5 μH; 2 ohms shunted by approximately 5 μH without a 50-ohm termination.

CAPACITIVE LOADING to a bare wire passing through the CT-1 transformer is typically 1.5 pF for #14 gauge, 0.6 pF for #20 gauge.

MAXIMUM VOLTAGE OF CIRCUIT UNDER TEST is 1000 V DC.

DIRECT CURRENT reduces the L/R time constant by a factor of 2 at 0.6 A.

PULSE CURRENT RATING is 100 A peak, with an amp-second product of 1 A-μs. When the A-s product is exceeded, the core saturates reducing the CT-1 output to zero.

RMS CURRENT RATING is 500 mA maximum.

TEMPERATURE RATING is −25° C to +65° C.

PHYSICAL DIMENSIONS are $\frac{3}{8} \times \frac{9}{16} \times 1\frac{13}{16}$ inches plus 6-32 x $\frac{1}{4}$ inch mounting stud.

P6040/CT-1 CURRENT PROBE, order 015-0041-00 . . **$40**
CT-1 CURRENT TRANSFORMER, order 015-0040-00 . **$21**
P6040 PROBE, order 010-0133-00 . . . . . **$19**

OPTIONAL ACCESSORY

GR to BNC, 50-Ω thru-line termination, order 017-0083-00 . $21

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

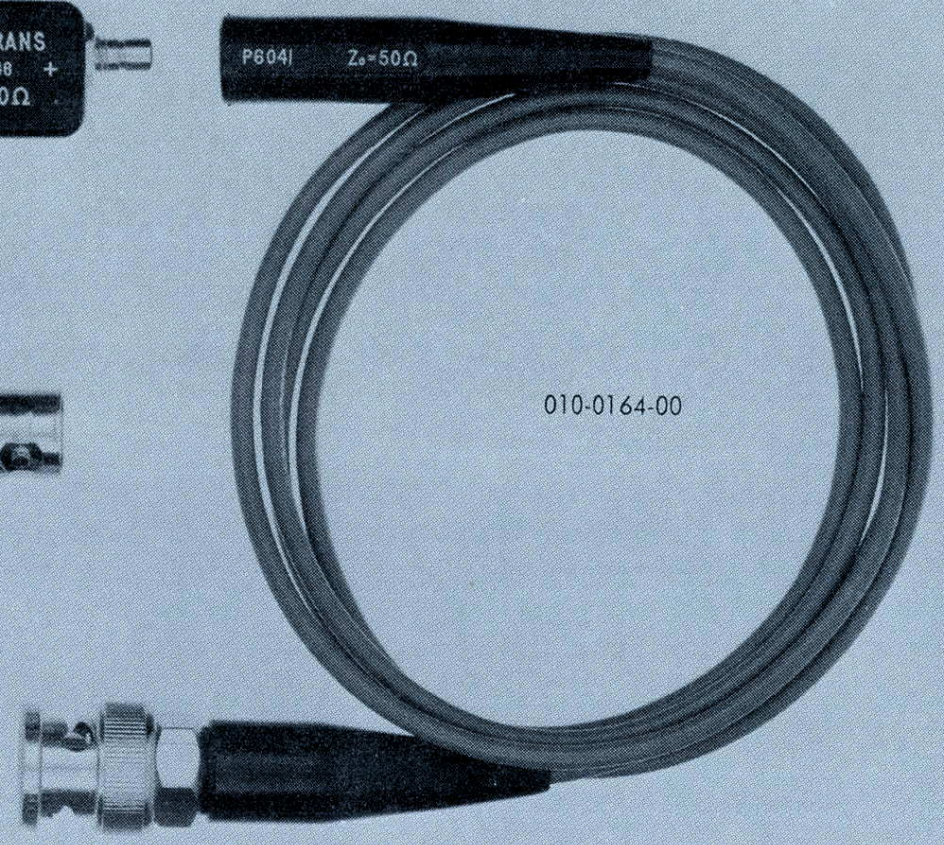
AC Current Probe

P6041/CT-2

1.2 kHz-TO-200 MHz

015-0046-00

011-0049-01



010-0164-00

The P6041/CT-2 Current Probe is designed for use with Tektronix DC-to-150 MHz Oscilloscopes. A 50-Ω termination is used in conjunction with the P6041/CT-2 for terminating the probe at the input of the oscilloscope.

The insulated case of the CT-2 Current Transformer is convenient to use in applications where limited circuit space exists. Several CT-2 Transformers may be placed throughout the circuit and monitored by one or more P6041 Probes.

P6041 PROBE

The P6041 Probe serves as an interconnecting cable between the CT-2 Transformer and the oscilloscope input. A 50-ohm termination is used in conjunction with the P6041 for terminating the probe at the high impedance input of the oscilloscope used.

Although designed for use with the CT-2, the P6041 Probe can be used with other test-point connectors, such as Amphenol Series 27 Sub-Minax or Sealectro Sub-Miniature RF.

IMPEDANCE is 50 ohms.

ATTENUATION is 1X.

OUTPUT CONNECTOR is BNC type.

CABLE LENGTH is 42 in. Additional 50-ohm cable can be used in series with the probe. RG8/U or RG58A/U cable is recommended to preserve the high-frequency response.

CT-2 CURRENT TRANSFORMER

SENSITIVITY is 1 mV/mA into a 50-ohm load. Accuracy better than ±3%.

DECAY TIME CONSTANT is 125 μs, approximated by 1% per 1.25 μs; limit, 25 μs.

RISETIME is approximately 0.5 ns.

FREQUENCY RESPONSE is 30% down at 1.2 kHz, 7% down at 200 MHz.

INSERTION IMPEDANCE with a 50-ohm termination is 0.04 ohms shunted by approximately 5 μH; 0.08 ohms shunted by approximately 5 μH without a 50-ohm termination.

CAPACITIVE LOADING to a bare wire passing through the CT-2 Transformer is typically 2.1 pF for #16 gauge, 0.7 pF for #22 gauge.

MAXIMUM VOLTAGE OF CIRCUIT UNDER TEST is 1000 V DC.

DIRECT CURRENT reduces the L/R time constant by a factor of 2 at 0.5 A.

PULSE CURRENT RATING is 100 A peak, with an amp-second product of 50 A-μs. When the A-s product is exceeded, the core saturates reducing the CT-2 output to zero.

RMS CURRENT RATING is 2.5 A maximum.

TEMPERATURE RATING is −25° C to +65° C.

PHYSICAL DIMENSIONS are $\frac{3}{8}$ x $\frac{9}{16}$ x $1\frac{13}{16}$ inches plus 6-32 x $\frac{1}{4}$ inch mounting stud.

P6041/CT-2 CURRENT PROBE, order 015-0047-00, **$47.50**
Includes: 50-Ω termination (011-0049-01); instruction manual (070-0406-01).

CT-2 CURRENT TRANSFORMER, order 015-0046-00 . . **$21**

P6041 PROBE, order 010-0164-00 . . . . . **$16.50**

50-OHM TERMINATION, order 011-0049-01 . . . . . **$10**

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

P6042 DC Current Probe P604

DC-TO-50 MHz 1-mA/DIV

The P6042 is a DC-to-50 MHz current probe designed for use with all Tektronix oscilloscopes. Utilizing a variation of the Hall effect, the P6042 offers new capabilities for making both high-frequency and DC current measurements. AC Signals with DC components can be displayed on the oscilloscope with true waveform presentation. The probe is particularly useful for evaluating the performance of semiconductor circuits where a wide range of parameters exist. Fast switching transients, low-frequency response, and DC level can all be displayed simultaneously.

The probe can also be used to measure the sums or differences of currents in separate wires. When the probe is clipped around two wires carrying current in the same direction, the sum is displayed. By reversing one of the wires, the difference is displayed. For increased sensitivity, several loops can be placed through the probe, increasing the sensitivity by the number of loops.

The P6042 consists of an amplifier with built-in power supply, 6-foot probe cable, and probe head. The probe is easy to use. Simply place the conductor* in the slot of the probe head and close the spring-loaded slide . . . no need to break the circuit under test. A warning light on the front panel of the amplifier indicates when the slide is in the unlocked position. A compartment is provided in the front panel for use in degaussing, and for convenient storage of the probe head when the system is not in use.

*Up to 0.150-inch diameter.

CHARACTERISTICS

Probe and Amplifier

SENSITIVITY is 1 mA/div to 1 A/div in 10 calibrated steps, 1-2-5 sequence, accurate within 3% (with an oscilloscope deflection factor of 50 mV/div).

BANDWIDTH is DC to 50 MHz at 3-dB down.

RISETIME is 7 ns or less.

DYNAMIC RANGE is + and — 10 divisions of display.

NOISE (periodic and random deviation) is 0.5 mA or less, plus 0.2 or less major divisions of display. Random trace shift is 1.5 mA or less.

THERMAL DRIFT is 2 mA/°C or less, plus 0.2 or less major division of display per °C.

MAXIMUM INPUT CURRENT is 10 A (DC plus Peak AC).*

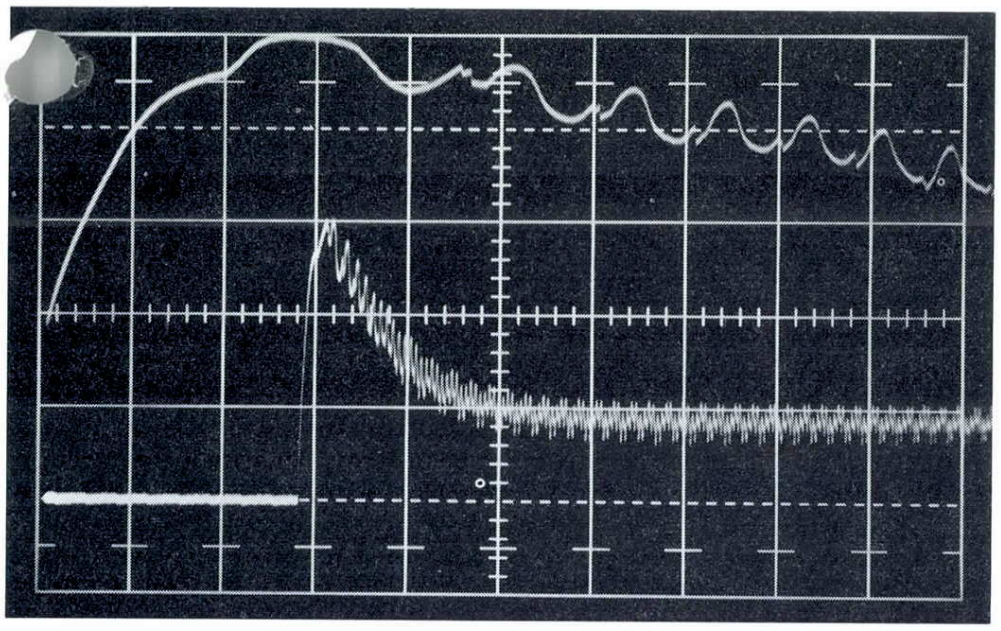
MAXIMUM VOLTAGE OF CIRCUIT UNDER TEST is 600 V (DC plus Peak AC).

OUTPUT IMPEDANCE is 50 Ω through a BNC-type connector. A 50-Ω termination is supplied with the probe for use with 1-megohm systems.

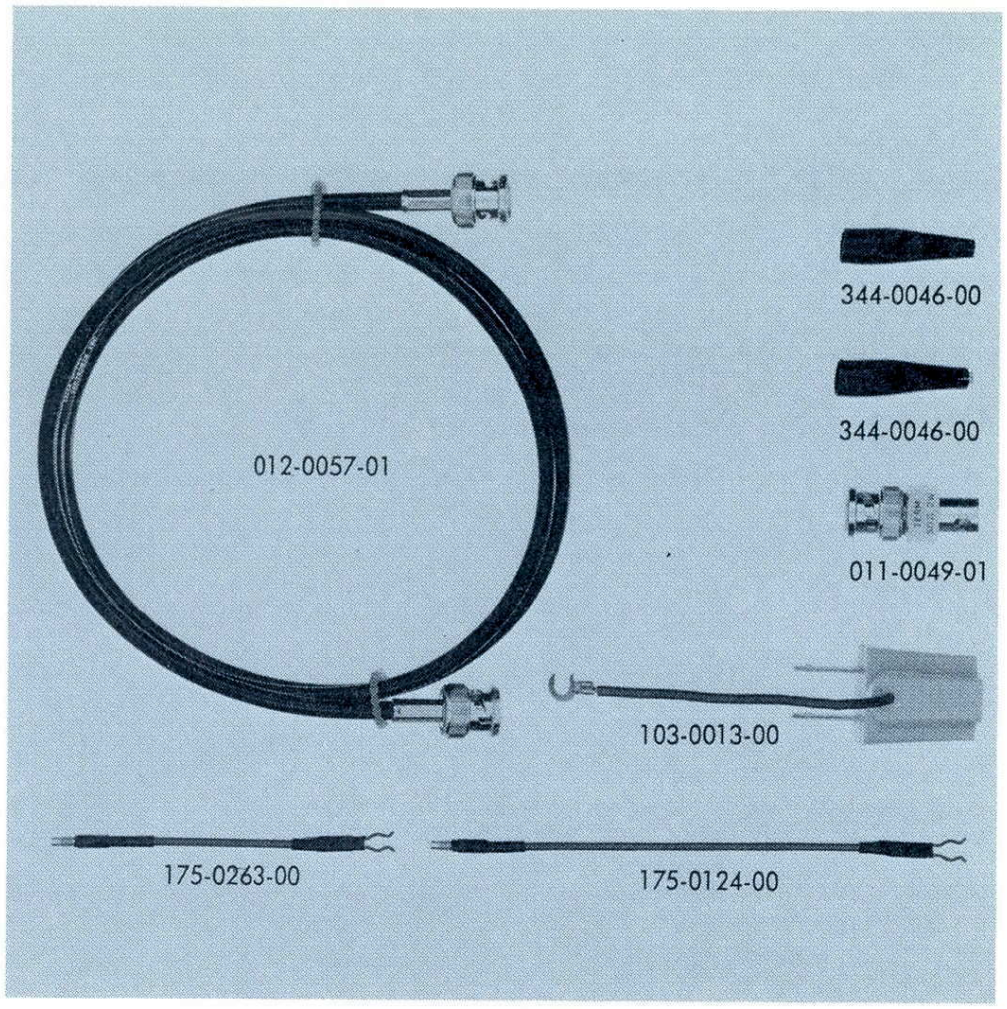
*Peak-to-peak current derating is necessary for CW frequencies higher than 10 MHz. At 50 MHz, the maximum allowable current is 2 A.

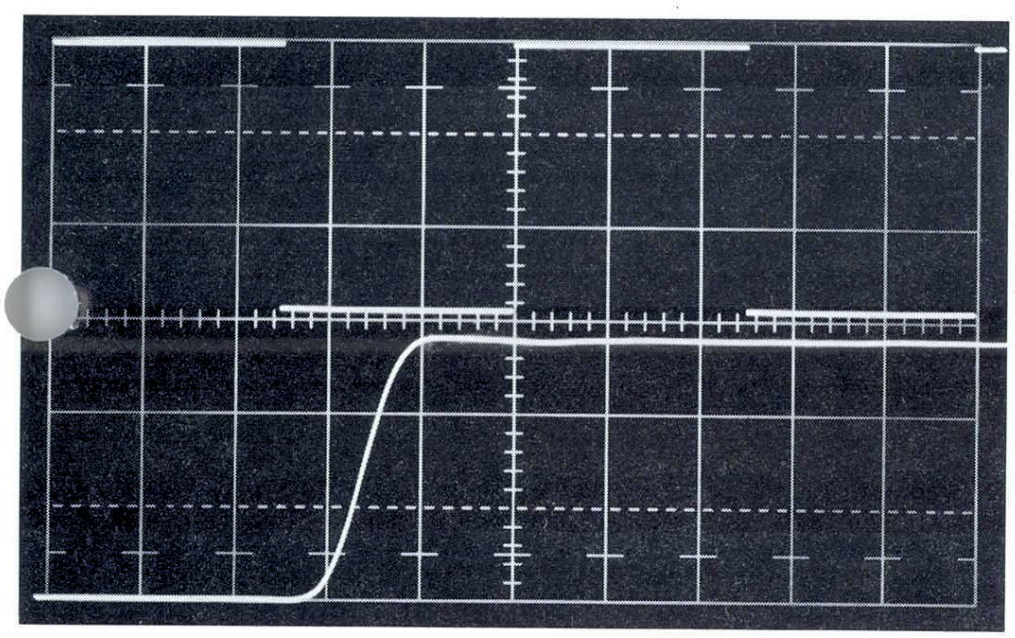
DC Current Probe

P6042



Double exposure photograph using the P6042 and a Type 547/1A5 Oscilloscope to display the current characteristics of a small DC motor. Lower display shows the zero current level, starting current, and running current. Current/div setting is 0.2 A/div with a sweep rate of 50 ms/cm. In the upper display, the sweep rate is increased to 5 ms/cm to show the current change as the commutator bars pass the brushes.





Upper display is a 60-Hz squarewave demonstrating the DC response of the P6042. The lower display is the same waveform at 10 ns/div. Double exposure photograph.

AMPLIFIER POWER REQUIREMENT is approximately 20 W, 50 Hz to 400 Hz. Quick-change line-voltage selector permits operation from 90 V to 136 V or 180 V to 272 V.

DIMENSIONS AND WEIGHT of the amplifier are 4½ in (11.4 cm) high by 7½ in (19.2 cm) wide by 9¾ in (24.8 cm) deep; 6½ lbs. (3.1 kg).

PROBE CABLE is 6 feet long, permanently connected between the probe head and amplifier.

P6042 DC CURRENT PROBE, order 010-0207-00 . . . **$690**
Includes: 50-Ω BNC cable (012-0057-01); 50-Ω BNC termination (011-0049-01); 3-inch ground lead (175-0263-00); 5-inch ground lead (175-0124-00); two alligator clips (344-0046-00); 3-wire to 2-wire adapter (103-0013-00); instruction manual (070-0629-00).

OPTIONAL ACCESSORY

BNC-to-GR Adapter, order 017-0063-00 ..... $6

U.S. Sales Prices FOB Beaverton, Oregon
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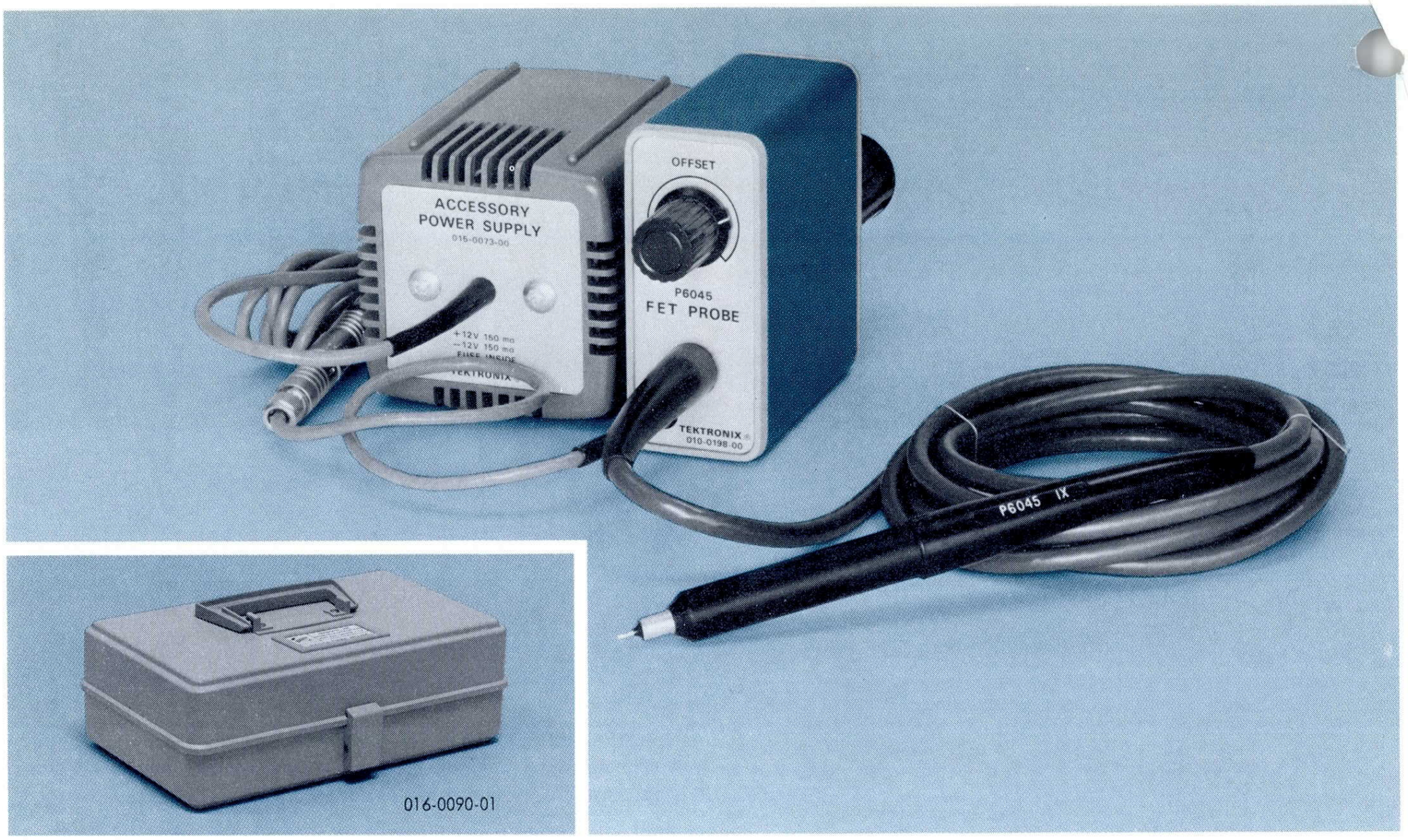


The P6045 FET Probe offers new capabilities for measuring small, high-frequency signals. Unlike many general-purpose probes which require built-in attenuation to reduce circuit loading, the P6045 utilizes a field effect transistor, resulting in reduced loading without sacrificing the gain of the measurement system.

This DC-to-230 MHz probe can be used with conventional oscilloscopes (1-MΩ inputs) and 50-Ω sampling oscilloscopes. Its small size makes it easy to use, particularly for applications involving compact circuitry. The probe also features a DC-offset control for measuring very small AC signals with DC potentials up to one volt.

Accessories supplied with the probe include 10X and 100X attenuator heads and an AC-coupling capacitor. Optional accessories include a probe power supply, and a tunnel diode pulser for checking the response of the probe.

The Accessory Power Supply permits the P6045 to be used with all Tektronix conventional oscilloscopes and 50-Ω sampling oscilloscopes. It provides the power required to operate one P6045. The Type 454 oscilloscope provides two P6045 probe power connectors.

CHARACTERISTICS

PROBE GAIN is adjustable to 1X.

RISETIME is 1.5 ns or less.

BANDWIDTH is DC to 230 MHz. Low-frequency 3-dB point with AC-coupling capacitor is less than 16 Hz.

INPUT RESISTANCE is 10 megohms.

INPUT CAPACITANCE is approximately 5.5 pF.

OUTPUT LOAD IMPEDANCE is 50 Ω. A switch on the compensating amplifier provides internal 50-Ω termination, or the probe can be terminated externally. This switching provision allows the P6045 to be used with either 50-ohm or 1-megohm systems. The probe may require recompensation when the termination is changed. Compensation is adjusted at the factory for 1-megohm systems.

DC-OFFSET RANGE is ±1 V, selected by variable front-panel control.

OUTPUT DYNAMIC RANGE is ±0.5-V peak.

INPUT DYNAMIC RANGE is ±0.5-V peak around a reference voltage which can be offset by 0 to ±1 V DC.

NOISE is less than 0.4 mV over a bandwidth of DC to 8 MHz, less than 1.5 mV over a bandwidth of DC to 230 MHz.

MAXIMUM INPUT VOLTAGE (Probe Only) is 12 V (DC + peak to peak AC)*.

PROBE POWER REQUIREMENTS are +12.5 V, ±5% at approx 50 mA; —12.5 V, ±5% at approx 100 mA.

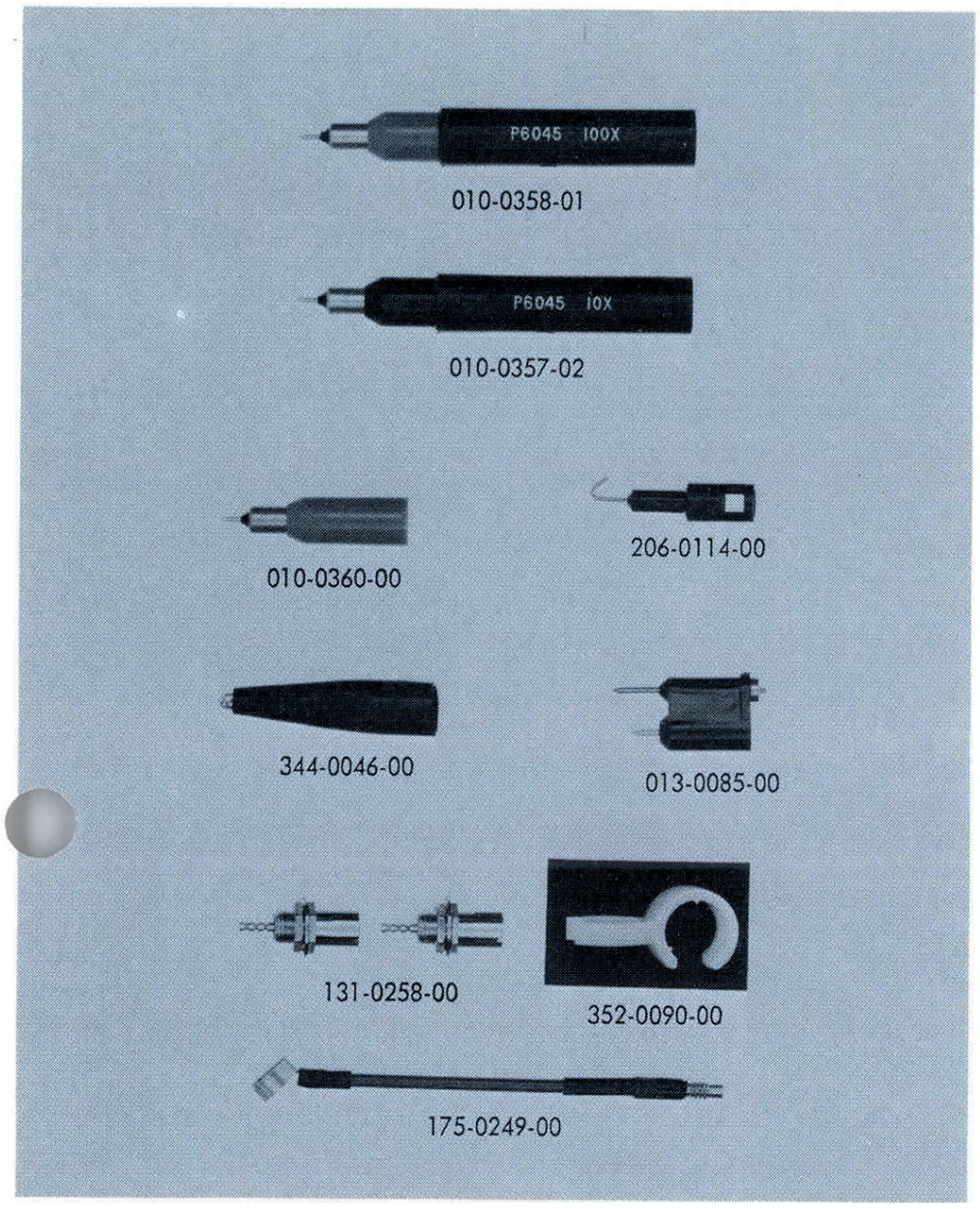
CABLE is 6 ft long. Output connector is locking BNC.

ACCESSORY POWER SUPPLY operates from 93 V-to-140 V or 186 V-to-280 V line.

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 9.5 MHz. Maximum input voltage at 230 MHz is 2 V.

PROBE CHARACTERISTICS WITH ACCESSORY HEADS

	Max-Voltage Input (DC + Peak AC)	*Attenuator Accuracy*	*Input C*
10X Attenuator	±100 V*	±3.5%	2.5 pF ±15%
100X Attenuator	±100 V	±3.5%	1.8 pF ±15%
AC-Coupling Capacitor	±200 V		6.0 pF



P6045 PROBE WITH ACCESSORY POWER SUPPLY, order 010-0205-00 ..... **$435**

P6045 PROBE, order 010-0204-00 ..... **$325**
Includes: 10X attenuator head (010-0357-02); 100X attenuator head (010-0358-01); AC-coupling capacitor head (010-0360-00); 2½-inch ground lead (175-0249-00); bayonet ground adapter (013-0085-00); hook tip (206-0114-00); alligator clip (344-0046-00); two test jacks (131-0258-00); probe holder (352-0090-00); carrying case (016-0090-01); two instruction manuals (070-0597-00).

POWER SUPPLY, order 015-0073-00 ..... **$110**
Power Supply includes: power cord (161-0025-01); 2 to 3-wire adapter (103-0013-00); instruction manual (070-0636-00).

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 18 MHz. Maximum input voltage at 230 MHz is 20 V.

OPTIONAL ACCESSORIES

The tunnel-diode pulser is used to adjust the P6045 FET Probe for optimum response. The pulser is designed to be driven by the 100-V output of the oscilloscope calibrator. Risetime of the probe pulser is less than 0.5 ns.

Probe Pulser, order 015-0088-00 ..... $31.00

Probe Tip to GR Adapter, order 017-0076-00 ..... 8.30

Probe Tip to BNC Adapter, order 013-0084-01 ..... 5.30

Probe Tip to GR Termination Adapter, order 017-0088-00 ..... 25.00

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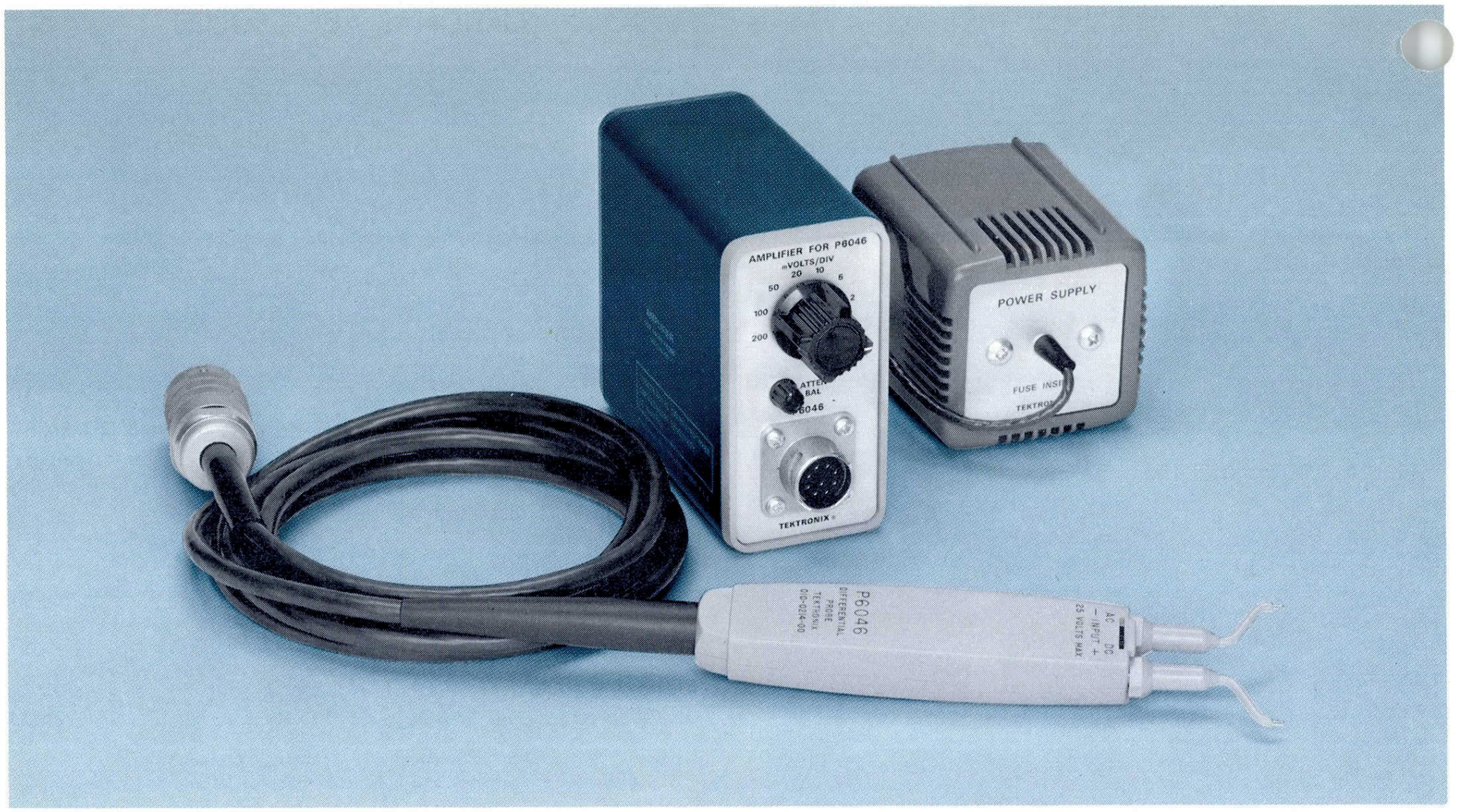


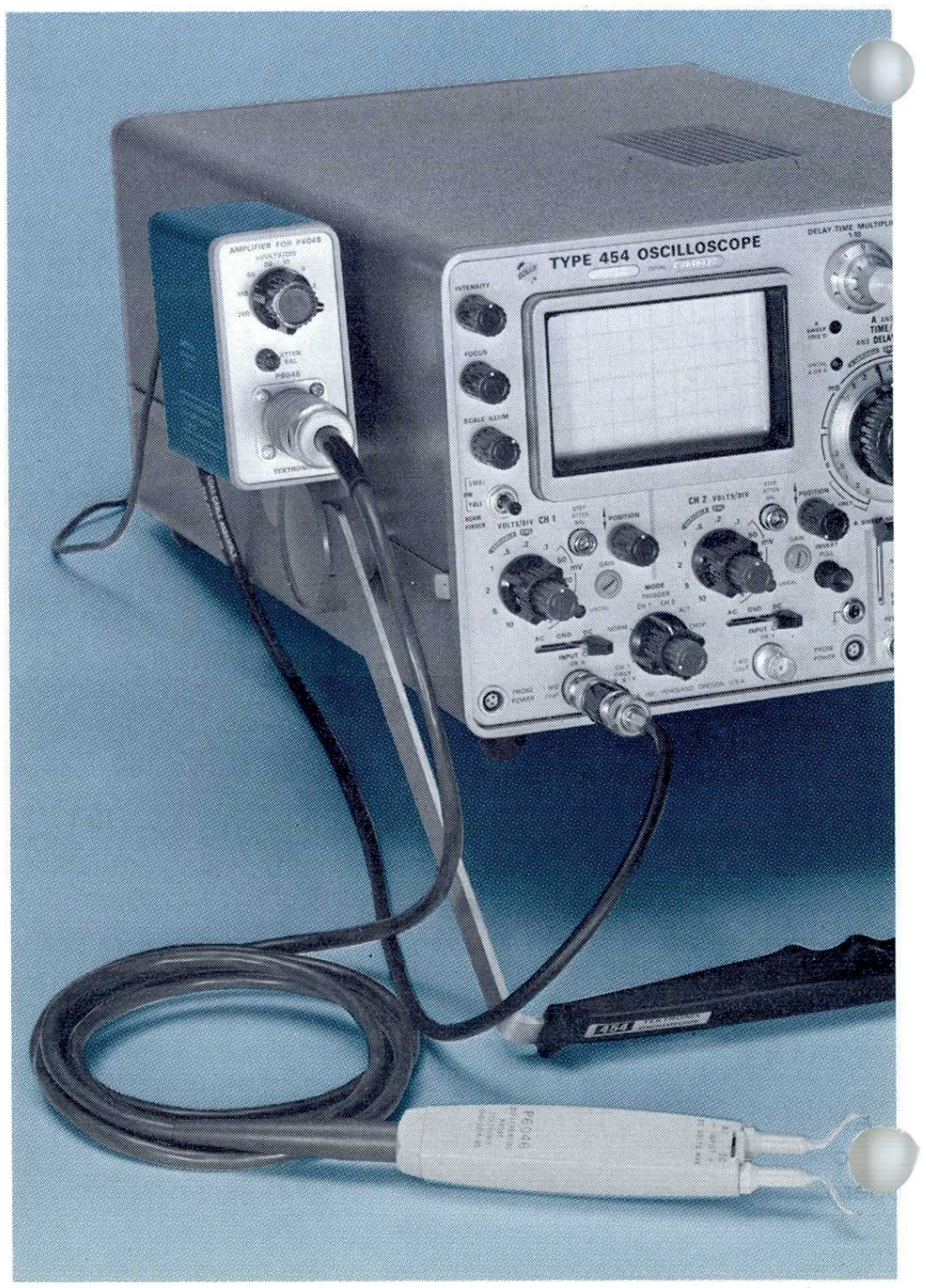
● *1,000:1 CMRR at 50 MHz*

The P6046 Differential Probe and P6046 Amplifier Unit provide new measurement capabilities when used with all Tektronix oscilloscopes. With this new probe system, the differential-signal processing takes place in the probe itself, resulting in high common-mode signal rejection at higher frequencies. Differential probe-tip signal processing minimizes the measurement errors caused by differences in probes, cable lengths, and input attenuators. In addition, the wide-band capability of the P6046 Probe and Amplifier provides DC-to-100 MHz single-ended and differential measurements.

The probe circuitry utilizes 13 semiconductors including dual FET's for the balanced input. A switch on the probe selects AC or DC input coupling. Accessories include a plug-on 10X attenuator for extending the differential input voltage range, and a ground tip for applications requiring single-ended input. Unique swivel tips provide variable spacing to accommodate varying distance between test points.

The P6046 Amplifier mounts conveniently on the side of the oscilloscope and features a calibrated 1-mV/div to 200-mV/div (2 V/div with 10X attenuator) deflection factor (oscilloscope deflection factor set at 10 mV/div). The output impedance of the amplifier is 50 Ω. A 50-Ω termination is supplied with the amplifier for use with 1-MΩ systems.

The P6046 Differential Probe may be used with the Type 1A5 Differential Amplifier with Tektronix Type 530, 540, 550, and 580-Series Oscilloscopes. The P6046 Probe extends the differential measurement capabilities of the Type 1A5 to 50 MHz. (CMRR is 1,000:1 at 50 MHz). The Type 1A5 supplies both probe power and amplification.



P6046 Differential Probe & Amplifier P6046

CHARACTERISTICS

Probe and Amplifier

DEFLECTION FACTOR is 1 mV/div to 200 mV/div in 8 calibrated steps, 1-2-5 sequence, accurate within 3% (with an oscilloscope deflection factor of 10 mV/div).

BANDWIDTH is DC-to-100 MHz at 3-dB down.

RISETIME is 3.5 ns or less.

COMMON-MODE REJECTION RATIOS with deflection factors of 1 mV/div to 20 mV/div are at least 10,000:1 at 50 kHz, 5,000:1 at 1 MHz and 1,000:1 from 10 MHz to 50 MHz.

COMMON-MODE LINEAR DYNAMIC RANGE is ±5 V.

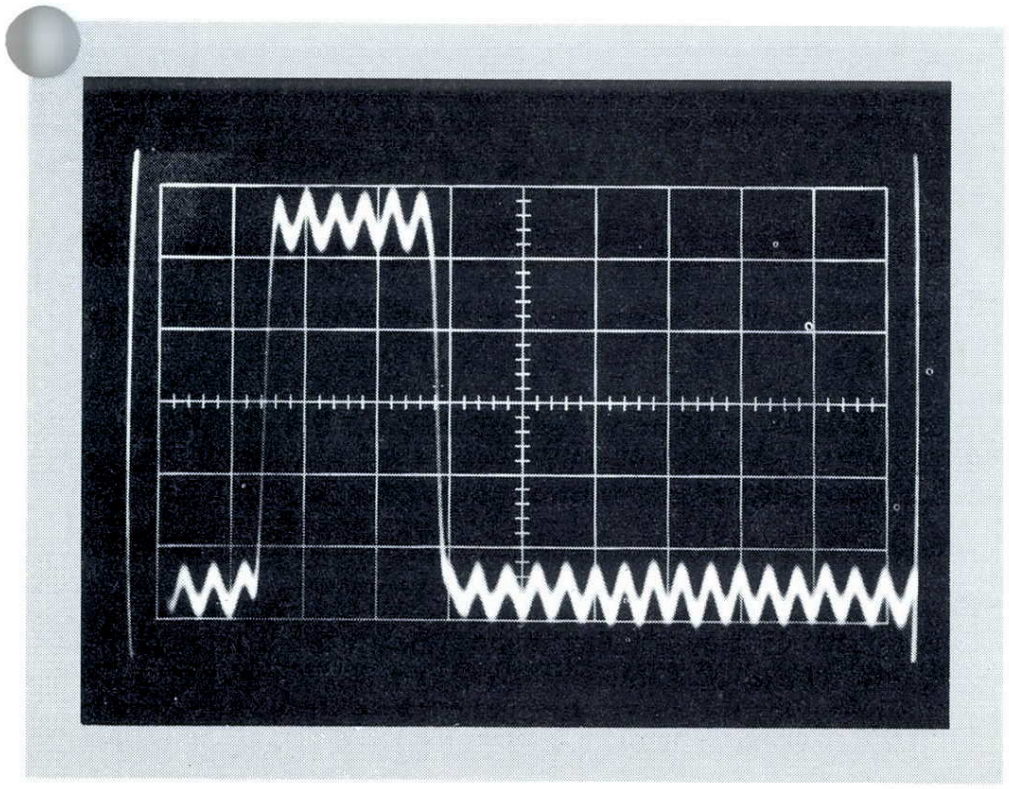
INPUT RC is 1 MΩ paralleled by ≤10 pF.

INPUT COUPLING is AC or DC, selected by a switch on the probe. Low-frequency response AC-coupled is 3-dB down at 20 Hz, 2 Hz with 10X attenuator.

DISPLAYED NOISE is 280 μV or less (tangentially measured).

MAXIMUM INPUT VOLTAGE is ±25 V (DC + peak AC), ±250 V with 10X attenuator.

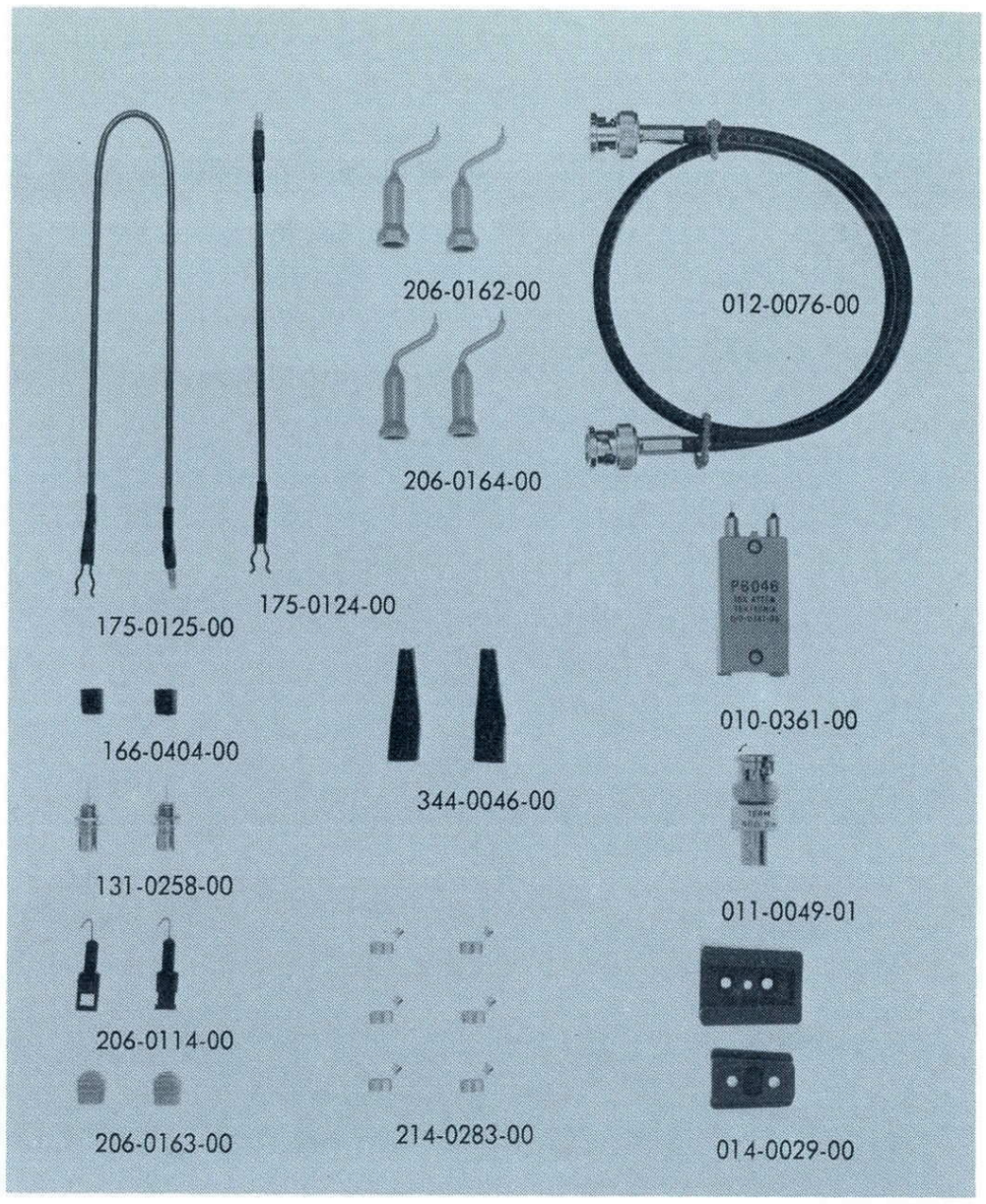
OUTPUT IMPEDANCE is 50 Ω through a BNC-type connector. A 50-Ω termination is supplied with the amplifier for use with 1-megohm systems.

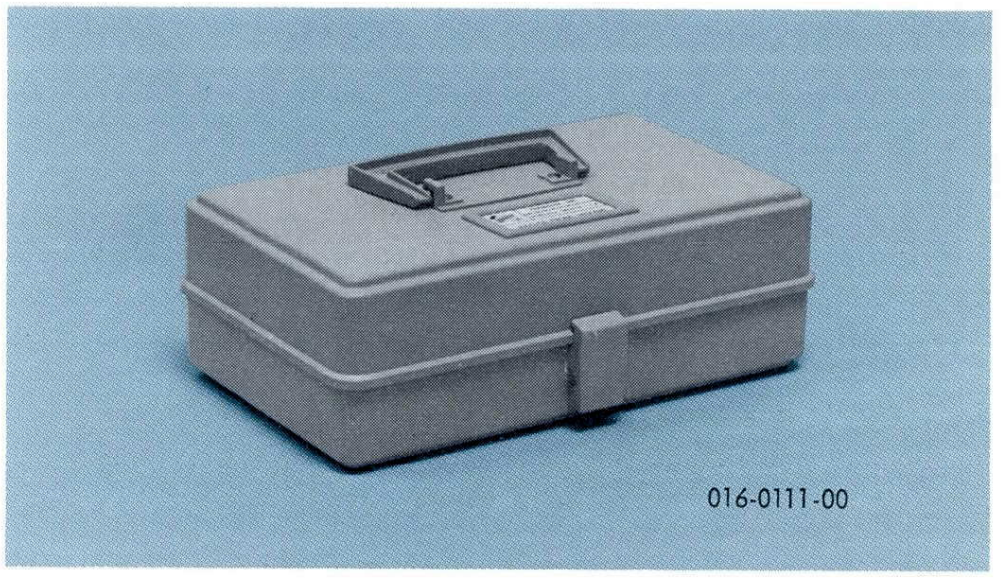


The photograph shows a 5-mV pulse with a 1-volt, 50-MHz common-mode signal (Vertical - 1 mV/div; Horizontal - 50 ns/div). The measurement was made using a P6046 Probe and Amplifier and a Type 454 Oscilloscope. It demonstrates the ≥1,000:1 common-mode rejection ratio of the P6046 Probe and Amplifier.

PROBE CABLE is 6 feet long, terminated with a special nine-pin connector.

AMPLIFIER POWER REQUIREMENTS are 10 watts maximum, [illegible]o 400 Hz. Factory wired for 105 V-to-125 V (117 V nominal) operation. Transformer taps permit operation at 210 V-to-250 V (234 V nominal). Instrument can be ordered factory wired for 210 V-to-250 V operation.





P6046 Probe and Amplifier, order 010-0232-00 . . **$800**
Includes: P6046 Probe Package (010-0213-00); Amplifier for P6046 and Power Supply (015-0106-00).

Amplifier for P6046, order 015-0106-00 . . . . . **$330**
Includes: Amplifier for P6046 and Power Supply; hanger assembly (014-0029-00); 50-Ω cable (012-0076-00); 50-Ω termination (011-0049-01); instruction manual (070-0756-00).

P6046 Probe, order 010-0213-00 . . . . . **$470**
Includes: P6046 Probe (010-0214-00); dual 10X attenuator head (010-0361-00); two swivel tip assemblies (206-0162-00); two swivel tip assemblies (206-0164-00); two ground tips (206-0163-00); 5-inch ground lead (175-0124-00); 12-inch ground lead (175-0125-00); two alligator clips (344-0046-00); two hook tips (206-0114-00); two test jacks (131-0258-00); two insulating tubes (166-0404-00); six ground clips (214-0283-00); carrying case (016-0111-00); instruction manual (070-0756-00).

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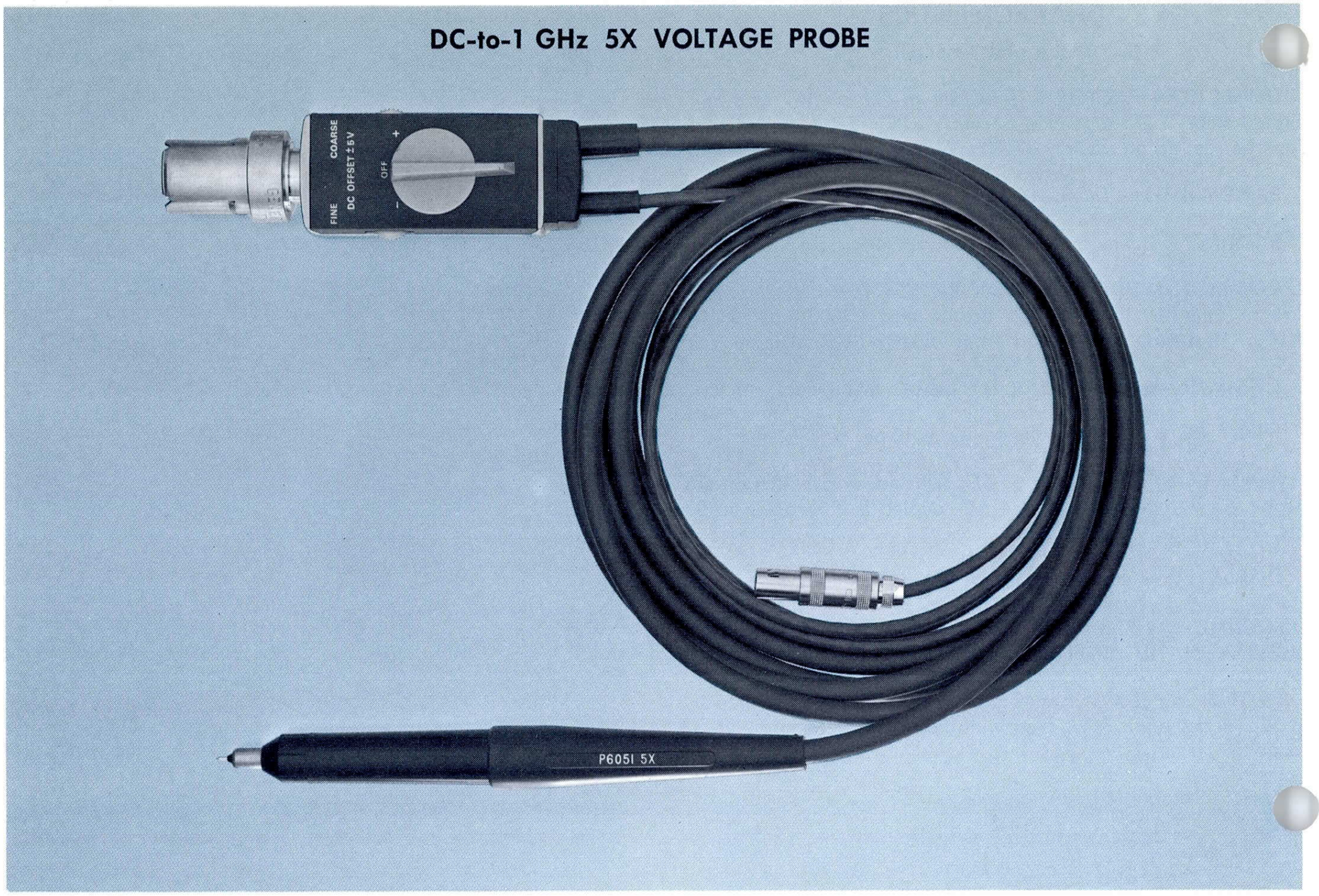
NEW

P6051 FET Probe P6051



The P6051 FET Probe offers new capabilities for measuring low-amplitude, very high-frequency signals. Its relatively low input capacitance and high input resistance result in reduced loading on the circuit under test.

This new DC-to-1 GHz probe can be used with conventional oscilloscopes (1-MΩ inputs) and 50-Ω sampling oscilloscopes. The probe also features a DC-offset control for measuring small AC signals with DC potentials up to 5 volts (200 V with the 40X attenuator).

The P6051 can be powered from the probe power out of the 7000-Series mainframes or by the Accessory Power Supply Type 1101. Among the optional accessories is an adapter which allows the probe to be powered from the Type 454 probe power out or from the accessory power supply, 015-0073-00.

CHARACTERISTICS

PROBE ATTENUATION—5X within 4%. Attenuator heads are accurate within 1%.

RISETIME—0.35 ns or less.

BANDWIDTH—DC to 1 GHz at 3-dB down. Low frequency 3-dB point with AC-coupling capacitor is approximately 175 Hz.

INPUT RESISTANCE—1 megohm with or without attenuators.

INPUT CAPACITANCE—approximately 2.8 pF.

OUTPUT LOAD IMPEDANCE—50 Ω. A 50-Ω termination is required when the probe is used with oscilloscopes having 1-MΩ input.

DC OFFSET RANGE— ±5 V (excluding attenuators), continuously variable coarse and fine controls select the amount of offset desired. Three-position switch turns offset function OFF or selects + or — polarity.

SIGNAL RANGE—(Probe terminated in 50 Ω)

Probe Input—At least ±2.5 V.

Probe Output—At least ±0.5 V.

Compression—5% or less with an input signal of 50 mV (over signal ranges specified).

NOISE (tangentially measured)—700 μV or less.

MAXIMUM PROBE INPUT VOLTAGE—200 V DC, AC peak, or DC and AC peak combined. Voltage derating is necessary for CW frequencies higher than 500 kHz. At 1 GHz the maximum allowable peak voltage is 20 V.

CABLE—6 feet long. Output connector is GR-Type.

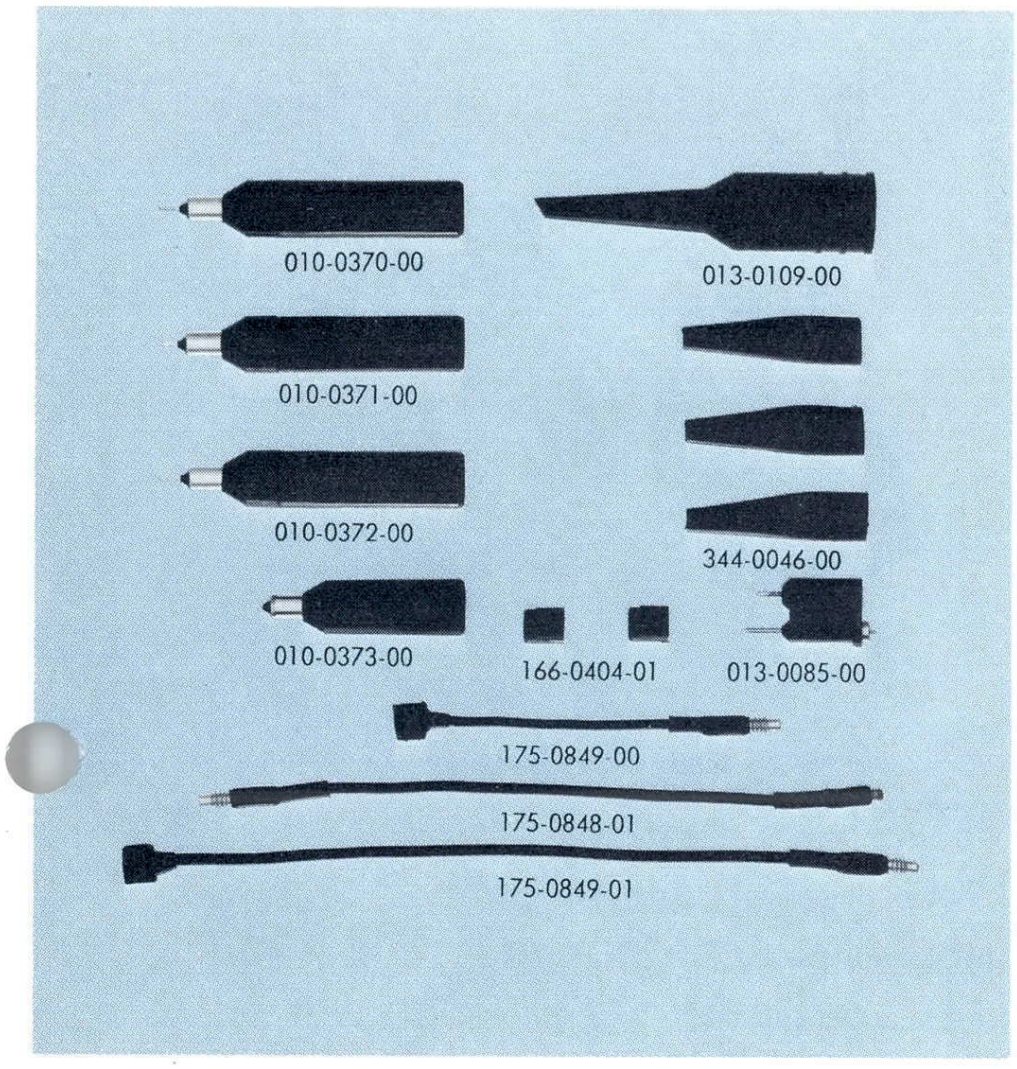
NEW

P6051 FET Probe P6051

PROBE CHARACTERISTICS WITH ATTENUATOR HEADS

	Input C	DC Offset	Max-Voltage Input	Max-Voltage Input at 1 GHz
4X Attenuator	3.25 pF	±20 V	±200 V*	7.5 V
20X Attenuator	2.0 pF	±100 V	±200 V*	17 V
40X Attenuator	1.8 pF	±200 V	±200 V*	22 V

*Voltage derating is necessary for CW frequencies higher than 2 MHz for the 4X attenuator, 75 MHz for the 20X attenuator, and 100 MHz for the 40X attenuator.

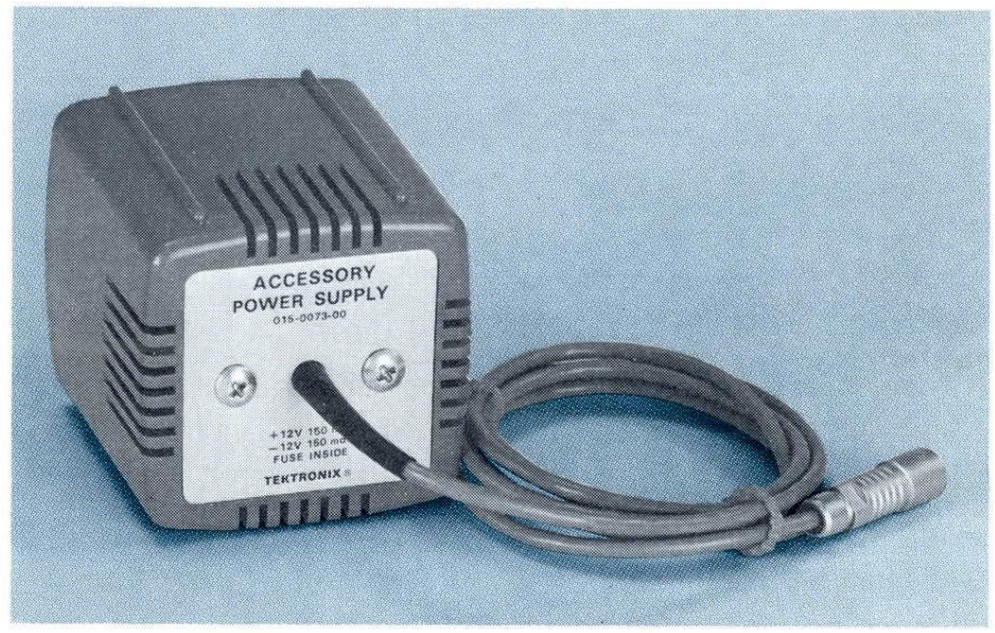


P6051 PROBE WITH ACCESSORIES,
order 010-0227-00 ..... $375
Includes: 4X attenuator head (010-0370-00); 20X attenuator head (010-0371-00); 40X attenuator head (010-0372-00); AC-coupling capacitor head (010-0373-00); retractable hook tip (013-0109-00); 5-inch ground lead (175-0848-01); bayonet ground adapter (013-0085-00); 3-inch nose ground lead (175-0849-00); 6-inch nose ground lead (175-0849-01); three minigator clips (344-0046-00); four end caps (200-1062-00); two insulating tubes (166-0404-01); carrying case (016-0156-00); one instruction manual (070-1009-00).

OPTIONAL ACCESSORIES

The Type 1101 Accessory Power Supply will power up to four P6051 Probes.

TYPE 1101 POWER SUPPLY $225
Includes: 2 to 3-wire adapter (103-0013-00); two instruction manuals (070-0949-00).



For powering only one P6051 Probe order
Accessory Power Supply, 015-0073-00 ..... $110
Includes: power cord (161-0025-01); 2 to 3-wire adapter (103-0013-00); instruction manual (070-0636-00).

Adapter cable, order 012-0187-00 ..... $20
Adapts P6051 power connector to the "Probe Power Out" of the Type 454 and also required for use with the Power Supply, 015-0073-00.

Probe tip to GR Termination Adapter,
order 017-0088-00 ..... $25

50-Ω termination, thru-line (GR to BNC Male),
order 017-0083-00 ..... $31

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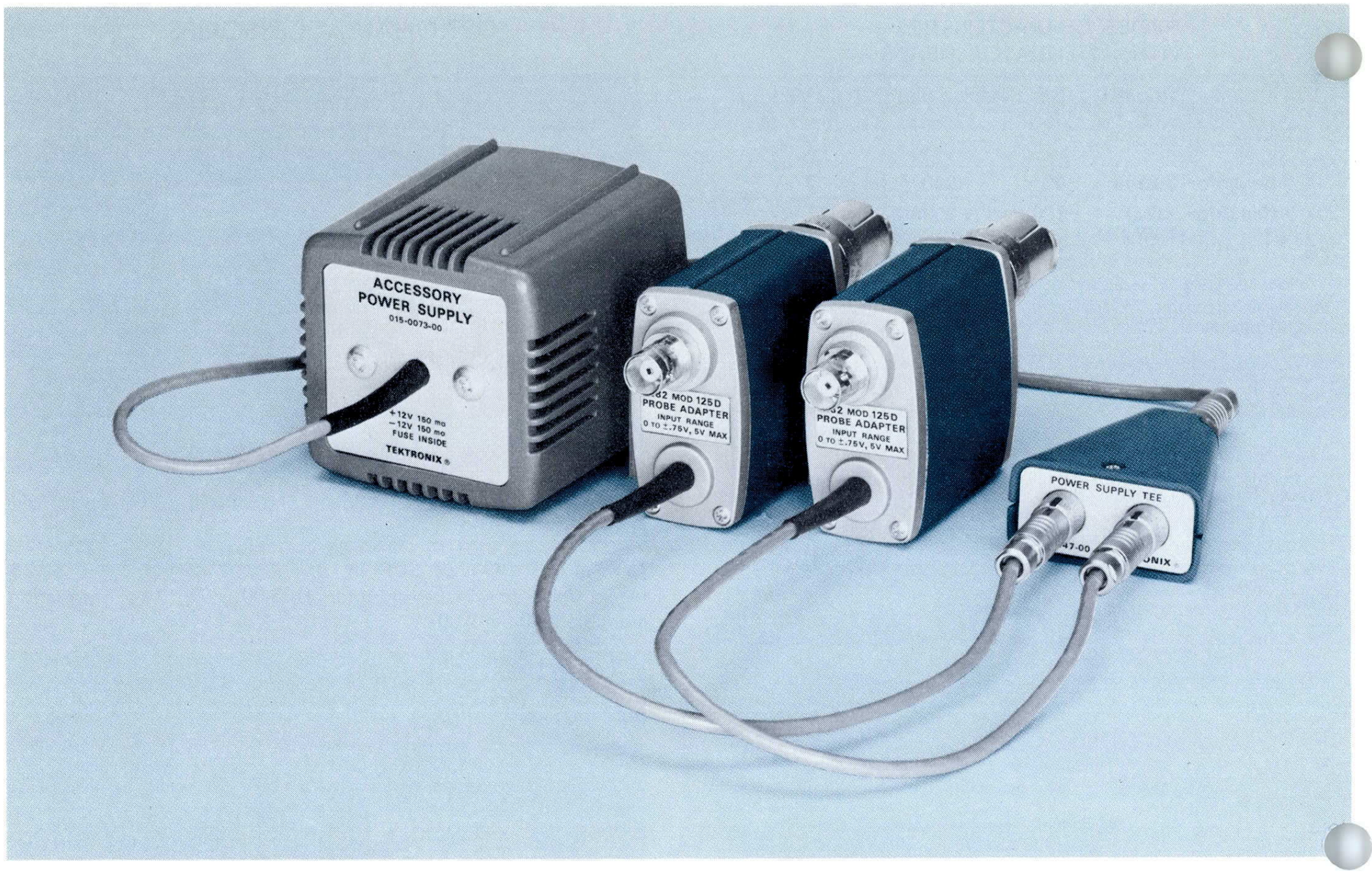
Probe Adapter

282



The Type 282 permits the use of conventional high-impedance probes with 50-Ω sampling plug-in units, such as Types 1S1 and 3S1. Power is obtained from their probe power connector. The Type 282 Mod 125D is a similar unit for use with the Types S-1 and S-2 in Type 3S2, 3S5 and 7S11 sampling plug-ins. Power is obtained from the accessory power supply.

Features of sampling such as DC offset, smoothing and overload recovery not normally available with a conventional oscilloscope are combined with the convenience of a high-impedance probe.

CHARACTERISTICS REFERRED TO PROBE TIP					
Probe	Overall Risetime	Input RC	Dynamic Range	Deflection Factor	Offset†
P6008 (10X)	≈4 ns	10 MΩ, 7.5 pF	±7.5 V	20 mV/cm to 2 V/cm	±10 V
P6009 (100X)	≈3.5 ns	10 MΩ, 2.5 pF	±75 V	200 mV/cm to 20 V/cm	±100 V
P6010 (10X)	≈3.5 ns	10 MΩ, 10 pF	±7.5 V	20 mV/cm to 2 V/cm	±10 V
P6011* (1X)	≈12 ns	1 MΩ, 42 pF	±0.75 V	2 mV/cm to 200 mV/cm	±1 V
P6047 (10X)	≈2.5 ns	10 MΩ 10 pF	±7.5 V	20 mV/cm 2 V/cm	±10 V
P6048 (10X)	≈4 ns	1 kΩ 1 pF	±7.5 V	20 mV/cm 2 V/cm	±10 V

*Care must be used to avoid exceeding the ±5 V max input limits of the Type 282.

†Usable offset limited to dynamic range of probe used.

RISETIME is 3 ns or less.

GAIN is unity ±3%, non-inverting.

INPUT RESISTANCE is 1 megohm.

INPUT CAPACITANCE is approximately 17 pF.

DYNAMIC RANGE is +750 mV to −750 mV into 50 Ω.

MAXIMUM INPUT is ±5 V (DC + peak AC).

NET WEIGHT is approx 2 lb.

TYPE 282, order 015-0074-00 ..... **$95**

TYPE 282 MOD 125D, order 015-0146-00 ..... **$100**

Each instrument includes: 2—instruction manuals (070-0544-00).

ACCESSORY POWER SUPPLY

The accessory power supply is a small compact voltage supply that provides + 12.5 and — 12.5 V DC operating from 93 V-to-140 V or 186 V-to-280 V line.

POWER SUPPLY, order 015-0073-00 ..... $110
Power Supply includes: power cord (161-0032-01); 2 to 3-wire adapter (103-0013-00); instruction manual (070-0636-00).

TEE CONNECTOR

The Tee Connector permits two Type 282 Mod 125D probe adapters to be attached to the output connector of the accessory power supply.

TEE CONNECTOR, order 015-0147-00 .....

U.S. Sales Price FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

NEW

1101 Accessory Power Supply 1101

The Type 1101 Accessory Power Supply is designed to power active probes, such as the Type P6051, when used with Oscilloscopes that do not have a probe power provision.

The Type 1101 will power up to four probes with outputs featuring short-circuit protection. A platform base provides storage for the power cord.

CHARACTERISTICS

POWER OUTPUT

+15 V supply (adjustable). Accuracy: ±0.75% (after initial setting).

−15 V supply. Accuracy: ±1.5%.
+5 V supply. Accuracy: ±2.0%.

Output Current: 400 mA from each supply, short-circuit protected.

Ripple Content: 1 mV or less, each supply with a 400 mA load.

OUTPUT CONNECTORS

Four special Lemo four-pin connectors, connected in parallel internally, provide the output facility.

POWER REQUIREMENTS

90 to 136 VAC or 180 to 272 VAC, 50 to 400 Hz; 39 watts, 390 mA maximum at 115 VAC and 60 Hz, high range; 47 watts, 455 mA maximum at 115 VAC and 60 Hz, low range. Side panel selector switches provide rapid accommodation for 115 V or 230 V line operation and high or low line-voltage ranges.

DIMENSIONS AND WEIGHTS

Height	3⅛ in	7.9 cm
Width	5¼ in	13.2 cm
Depth	8¼ in	20.9 cm
Net weight	3½ lb	1.6 kg

INCLUDED STANDARD ACCESSORIES

3 to 2-wire adapter (103-0013-00); 2 instruction manuals (070-0949-00); ≈6 foot power cord attached.

TYPE 1101 POWER SUPPLY $225

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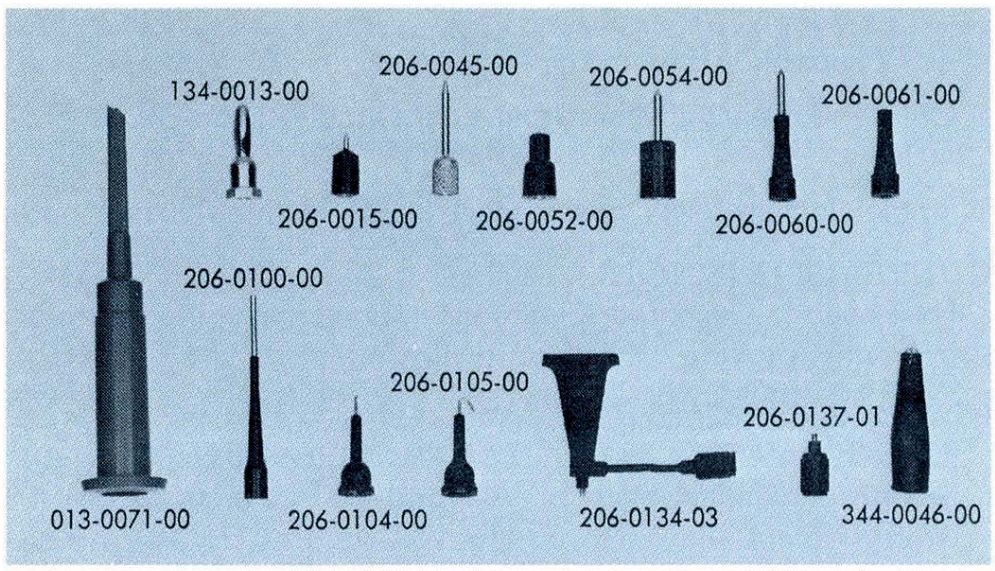
Please refer to Terms and Shipment, General Information page.

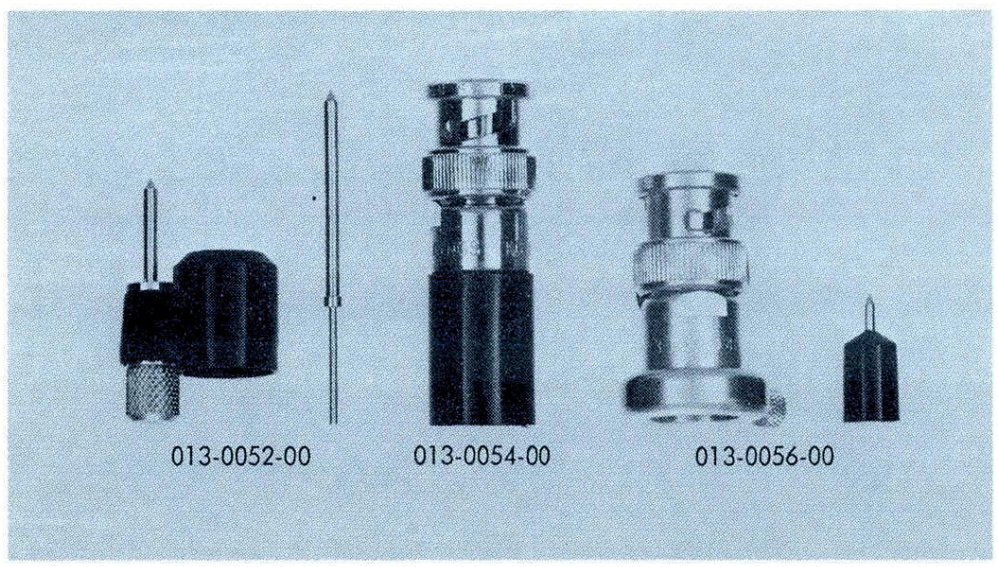
Probe Accessories

PROBE TIPS AND ADAPTERS

The following tips and adapters can be used on all Tektronix Probes that accept a #6-32 screw-on tip including the P6006, P6007, P6008, P6009, P6027 and P6028 Probes.



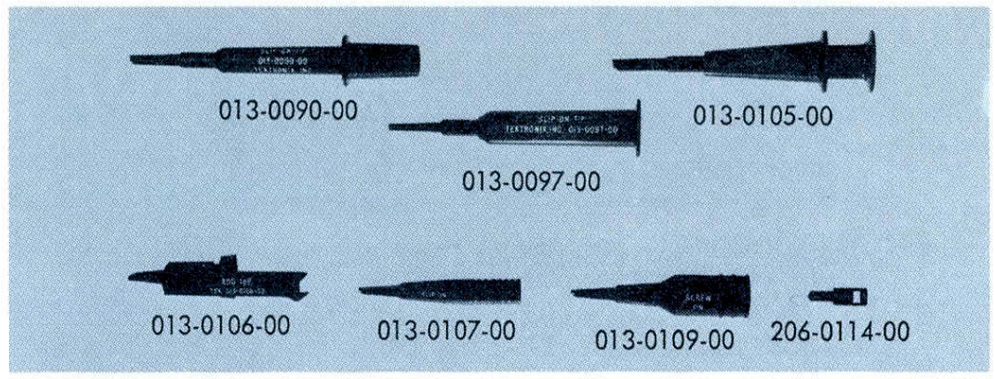
Calibration Tip (0.063 in dia)	206-0100-00	$1.00
Straight Tip (0.080 in dia)	206-0045-00	.30
Straight Tip (0.086 in dia)	206-0054-00	.40
Long Straight Tip (0.032 in dia)	206-0104-00	.30
Spring Tip (0.080 in dia)	206-0060-00	.55
Spring Tip (accepts 0.065 in pin or plug)	206-0061-00	.50
Recessed Tip (accepts 0.065 in recessed pin or plug)	206-0052-00	.30
Short Straight Tip (0.055 in dia)	206-0015-00	.30
Banana Tip	134-0013-00	.15
Minigator Tip	344-0046-00	.25
Hook Tip	206-0105-00	.30
Retractable Hook Tip (for P6006, P6007, P6008, P6009, P6023, P6027, P6028)	013-0071-00	2.20
Probe Tip (accepts 0.025 in x 0.025 in pins)	206-0134-03	$1.75
Ground Lead Adapter (6-32 to 0.025 in x 0.025 in pin)	206-0137-01	.60



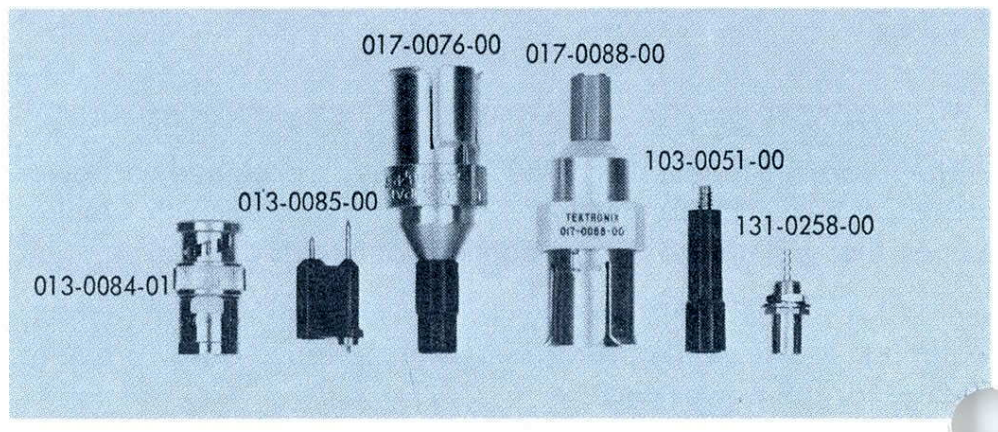
Probe Tip to BNC Adapter (for P6006, P6007, P6008, P6009)	013-0054-00	2.75
Probe Tip to BNC Adapter (for P6023, P6027, P6028)	013-0056-00	3.30
Bayonet Ground Assembly (for P6006, P6007, P6008, P6009)	013-0052-00	2.50

MINIATURE PROBE TIPS AND ADAPTERS

The following tips and adapters are designed for use w Tektronix Miniature Probes that accept a slip-on tip.

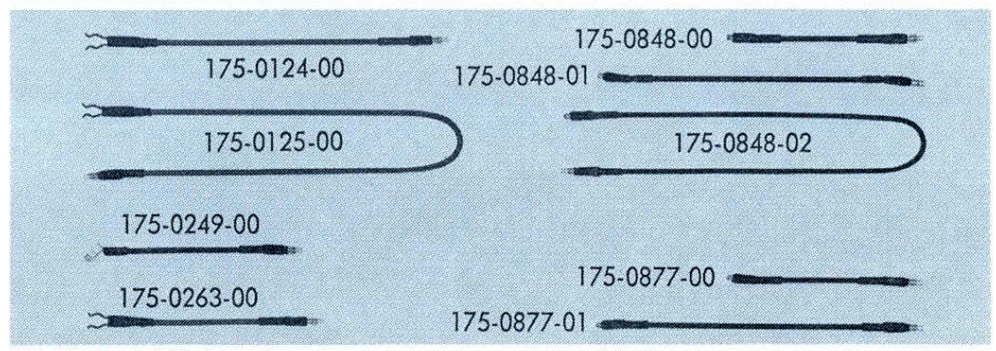


Hook Tip	206-0114-00	.90
Retractable Hook Tip (for P6010, P6011, P6012, P6047, P6048, P6049)	013-0090-00	2.20
Retractable Hook Tip (for S-3, P6045)	013-0097-00	2.20
Retractable Hook Tip (for P6051)	013-0109-00	2.20
Retractable Hook Tip (for P6052)	013-0105-00	2.20
Retractable Hook Tip (for P6053)	013-0107-00	2.20
Retractable Hook Tip (for 7A11)	013-0106-00	2.20



Miniature Probe to 6-32 Adapter (adapts miniature probes for use with all #6-32 screw-on tips)	103-0051-00	$ .85
Probe Tip to GR Adapter	017-0076-00	8.30
Probe Tip to BNC Adapter	013-0084-01	5.30
Bayonet Ground Assembly	013-0085-00	2.75
Chassis Mount Test Jack	131-0258-00	1.50
Probe Tip to GR Termination Adapter	017-0088-00	25.00

PROBE GROUND LEADS

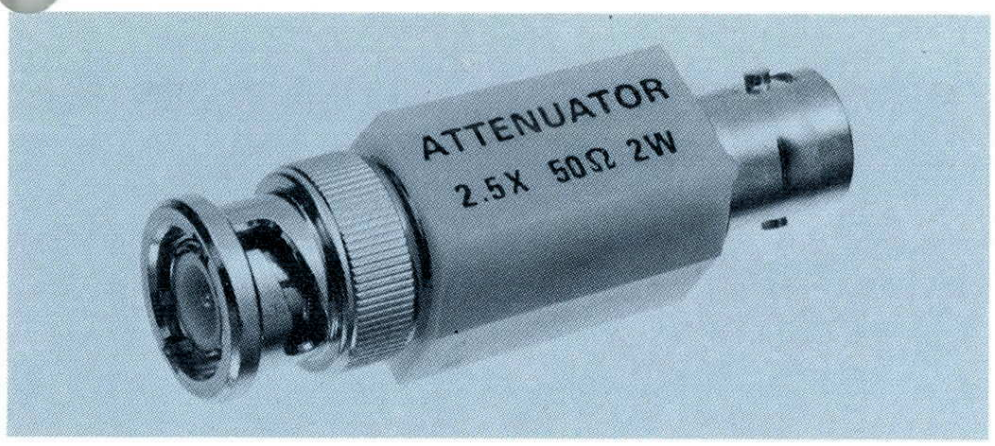


The following Ground Leads have a 6-32 thread size.

DESCRIPTION		PART NUMBER	PRICE
3-inch Ground Lead		175-0263-00	$ .60
5-inch Ground Lead		175-0124-00	.60
12-inch Ground Lead		175-0125-00	.60
2½-inch Ground Lead (for P6034, P6035, P6045, S-3)		175-0249-00	1.10
Ground Leads for P6051, P6052:	3-inch	175-0848-00	.60
	5-inch	175-0848-01	.60
	12-inch	175-0848-02	.60
Ground Leads for P6053:	3-inch	175-0877-00	.60
	5-inch	175-0877-01	.60

Accessories With BNC Connectors

ATTENUATORS—TERMINATIONS



DESCRIPTION	PART NUMBER	PRICE
50-Ω feedthrough termination	011-0049-01	$10.00
50-Ω feedthrough (5 watt)	011-0099-00	15.50
50-Ω 2X attenuator	011-0069-01	12.00
50-Ω 2.5X attenuator	011-0076-01	12.00
50-Ω 5X attenuator	011-0060-01	12.00
50-Ω 10X attenuator	011-0059-01	12.00

CHARACTERISTICS

Accuracy of Indicated Attenuation Ratio is ±2% at DC; ±3% at 500 MHz.

Voltage Standing Wave Ratio (VSWR) is less than 1.1 up to 250 MHz.

Power Rating is 2 watts.

DESCRIPTION	PART NUMBER	PRICE
50-Ω to 75-Ω min loss attenuator	011-0057-00	$13.25
50-Ω to 93-Ω min loss attenuator	011-0058-00	13.25
75-Ω feedthrough termination	011-0055-00	10.00
75-Ω 10X attenuator	011-0061-00	12.00
93-Ω feedthrough termination	011-0056-00	10.00
93-Ω 10X attenuator	011-0062-00	12.00

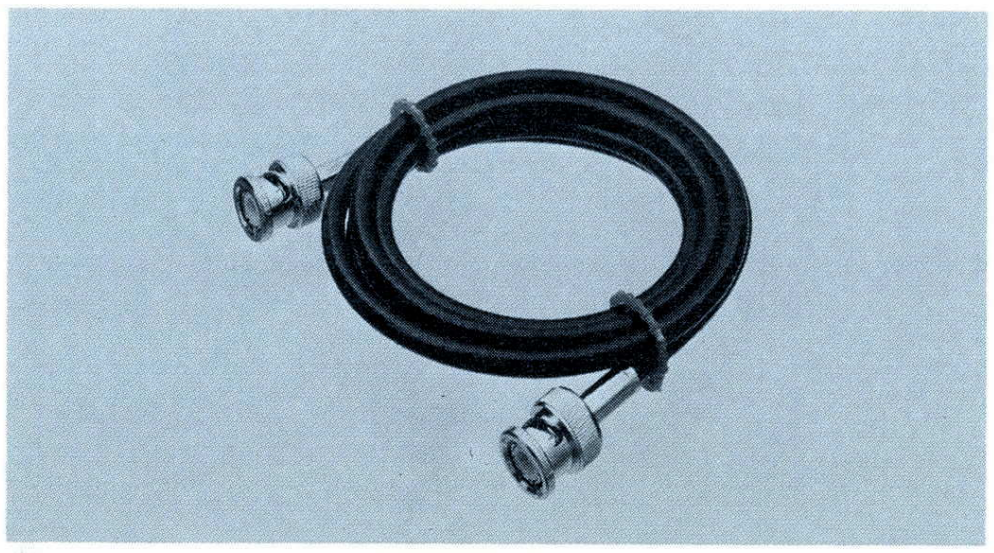
CHARACTERISTICS

Accuracy of Indicated Attenuation Ratio is ±2% at DC.

Power Rating of attenuators is ½ watt and terminations 1 watt.

DESCRIPTION	PART NUMBER	PRICE
600-Ω feedthrough termination (1 watt, DC to 1 MHz)	011-0092-00	$16.50

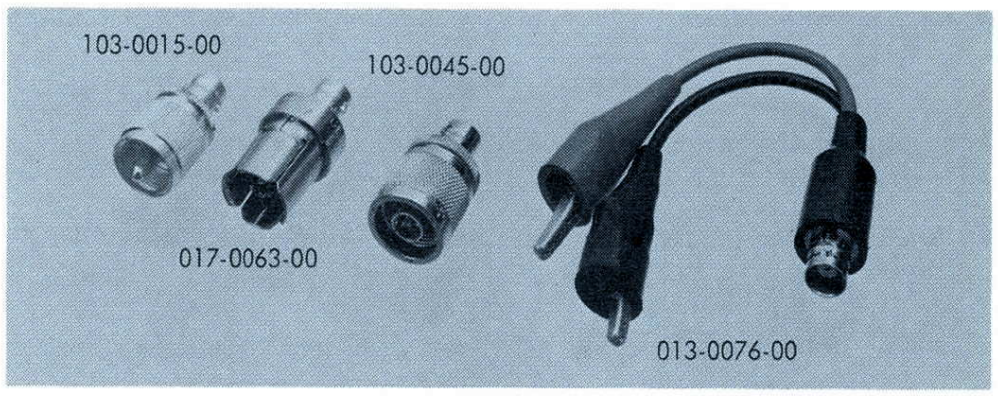
CABLES



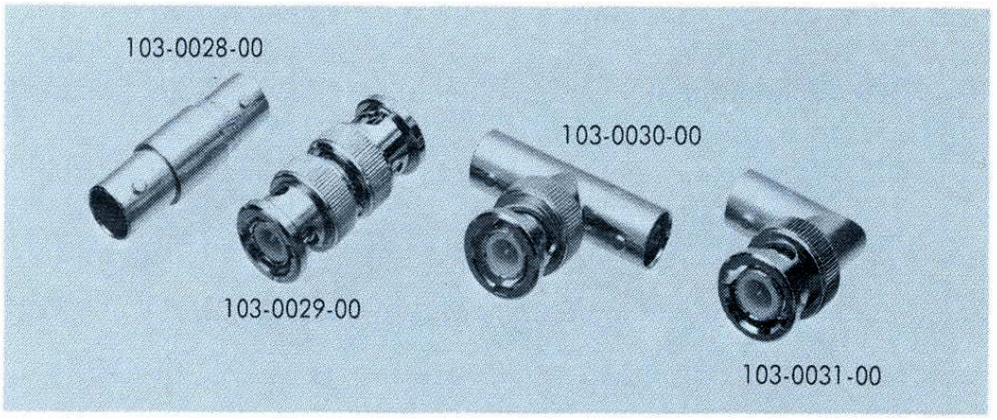
Coaxial, 50 Ω, 18 in, order 012-0076-00	$5.80
Coaxial, 50 Ω, 42 in, order 012-0057-01	5.80
Coaxial, 75 Ω, 42 in, order 012-0074-00	5.80
Coaxial, 93 Ω, 42 in, order 012-0075-00	5.80

ADAPTERS

DESCRIPTION	PART NUMBER	PRICE
BNC Male to UHF Female	103-0032-00	$2.00
BNC Male to GR	017-0064-00	8.00
BNC Male to N Female	103-0058-00	2.40
BNC Male to Binding Post	103-0033-00	2.20
BNC Male to Dual Binding Post	103-0035-00	5.80



BNC Female to UHF Male	103-0015-00	1.80
BNC Female to GR	017-0063-00	6.00
BNC Female to N Male	103-0045-00	2.40
BNC Female to clip leads	013-0076-00	4.40



BNC Female to BNC Female	103-0028-00	2.10
BNC Male to BNC Male	103-0029-00	3.30
BNC T	103-0030-00	3.70
BNC Elbow Male to Female	103-0031-00	2.50

Accessory housing without electrical components is useful for applications requiring special circuitry.

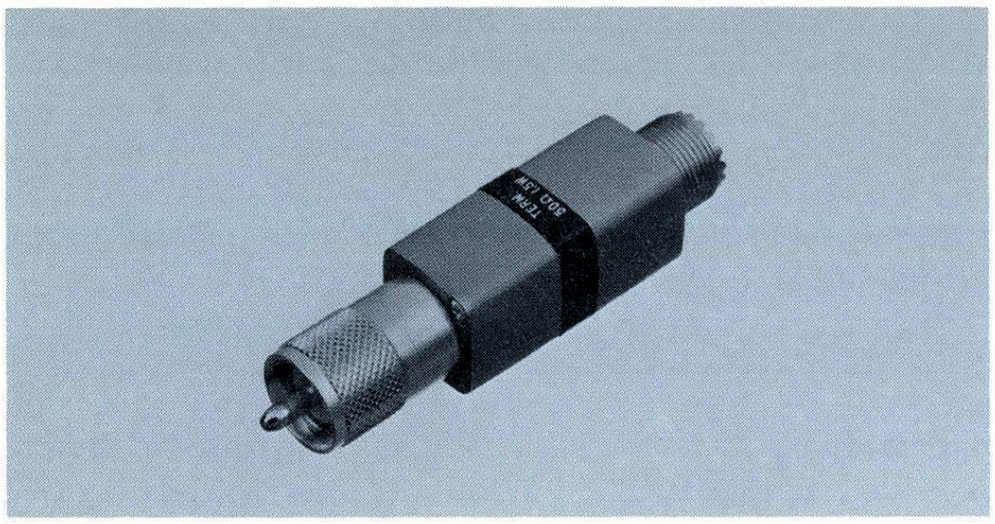
Order 011-0081-00 ..... $6.60

U.S. Sales Prices FOB Beaverton, Oregon

Please refer to Terms and Shipment, General Information page.

Accessories With UHF Connectors

ATTENUATORS—TERMINATIONS



DESCRIPTION	PART NUMBER	PRICE
50-Ω feedthrough termination	011-0045-00	17.00
50-Ω 5X attenuator	011-0032-00	20.00
50-Ω 10X attenuator	011-0031-00	20.00

CHARACTERISTICS

Accuracy of Indicated Attenuation Ratio is ±2% at DC; ±3% at 100 MHz.

Voltage Standing Wave Ratio (VSWR) is less than 1.2 up to 100 MHz.

Power Rating is 1.5 watts.

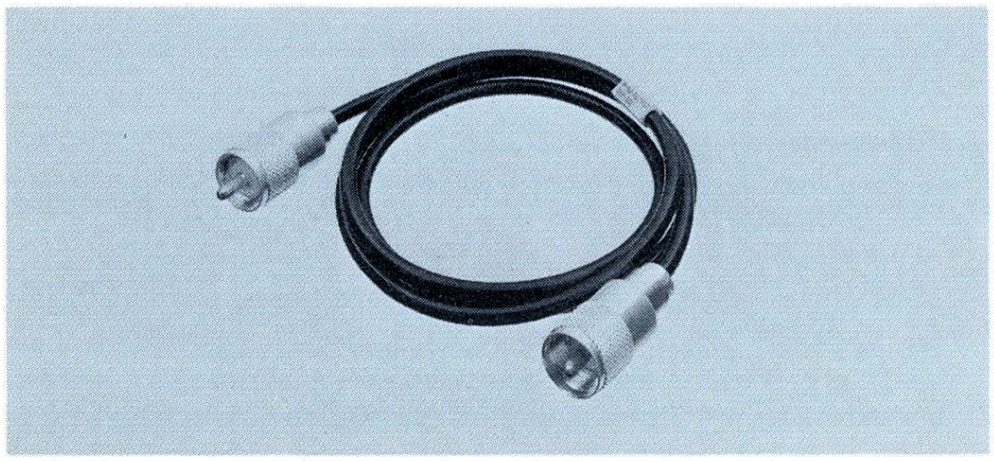
DESCRIPTION	PART NUMBER	PRICE
50-Ω to 75-Ω min loss attenuator	011-0041-00	$20.00
50-Ω to 93-Ω min loss attenuator	011-0042-00	20.00
50-Ω to 170-Ω min loss attenuator	011-0043-00	20.00
75-Ω feedthrough termination	011-0046-00	17.00
75-Ω 5X attenuator	011-0034-00	20.00
75-Ω 10X attenuator	011-0033-00	20.00
93-Ω feedthrough termination	011-0047-00	17.00
93-Ω 5X attenuator	011-0036-00	20.00
93-Ω 10X attenuator	011-0035-00	20.00
170-Ω feedthrough termination	011-0048-00	17.00

CHARACTERISTICS

Accuracy of Indicated Attenuation Ratio is ±2% at DC.

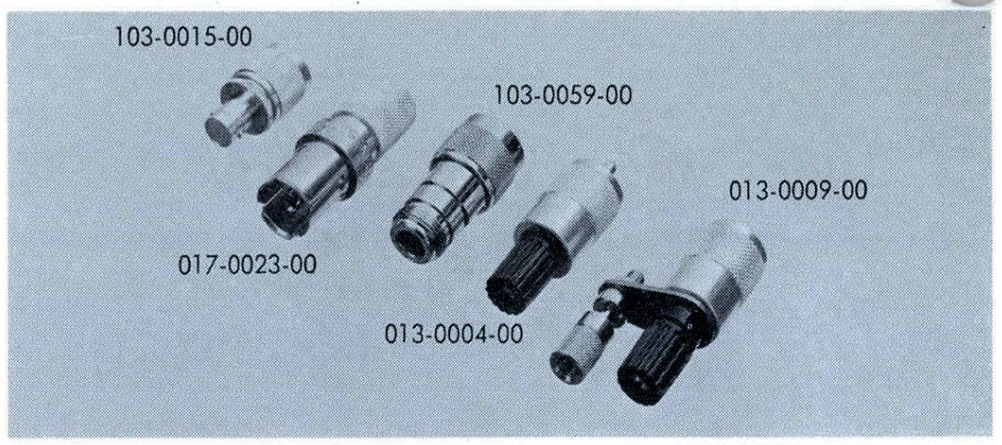
Power Rating is 1.5 watts.

CABLES

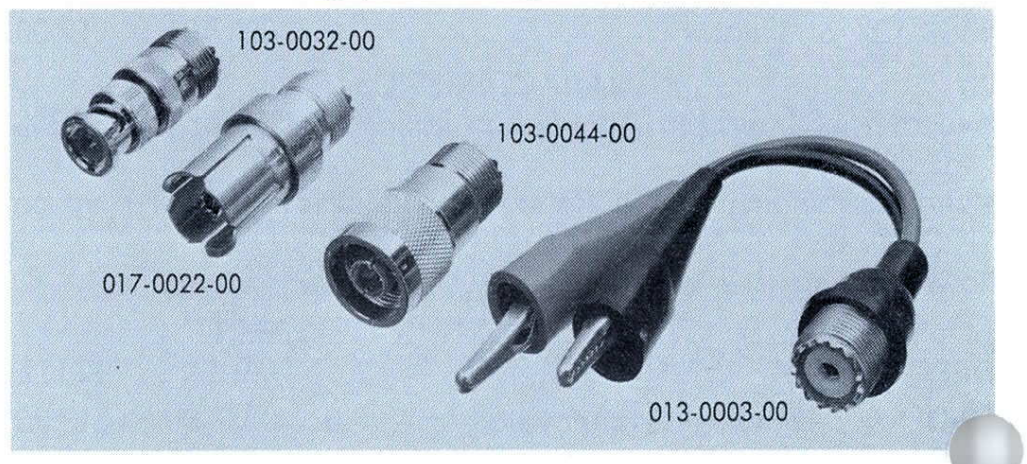


Coaxial, 50 ohm, 42 in, order 012-0001-00	$8.30
Coaxial, 75 ohm, 42 in, order 012-0083-00	8.30
Coaxial, 93 ohm, 42 in, order 012-0003-00	8.30
Coaxial, 170 ohm, 42 in, order 012-0006-00	10.75

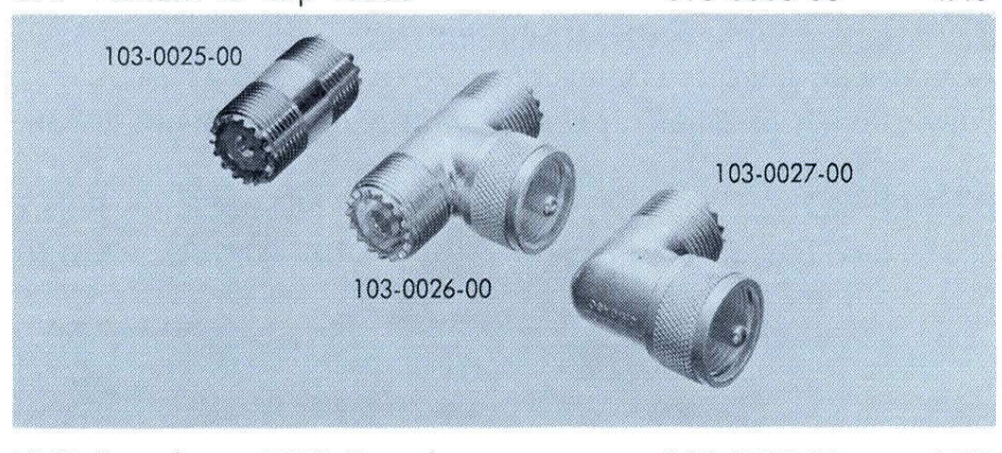
ADAPTERS



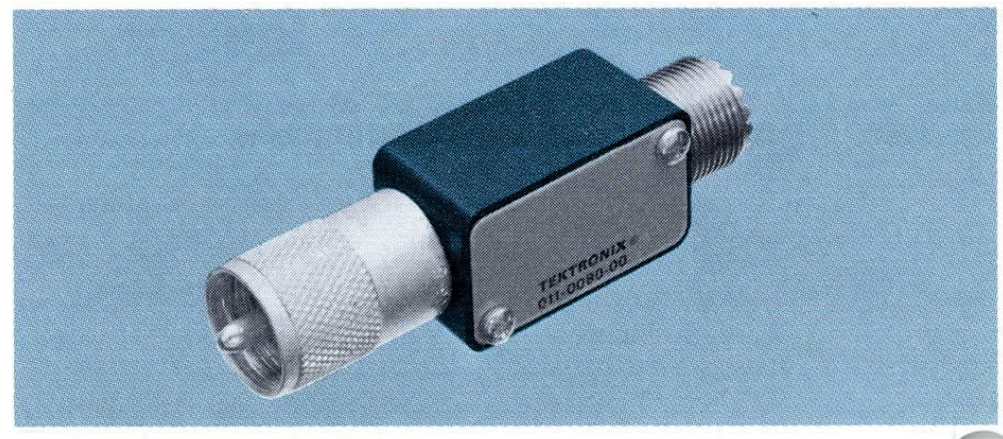
DESCRIPTION	PART NUMBER	PRICE
UHF Male to BNC Female	103-0015-00	$1.80
UHF Male to GR	017-0023-00	6.00
UHF Male to N Female	103-0059-00	2.50
UHF Male to binding post	013-0004-00	2.20
UHF Male to binding post with gnd	013-0009-00	3.30



UHF Female to BNC Male	103-0032-00	$2.00
UHF Female to GR	017-0022-00	6.50
UHF Female to N Male	103-0044-00	3.90
UHF Female to clip leads	013-0003-00	4.40



UHF Female to UHF Female	103-0025-00	2.75
UHF T Male to 2 Female	103-0026-00	3.70
UHF Elbow Male to Female	103-0027-00	2.50



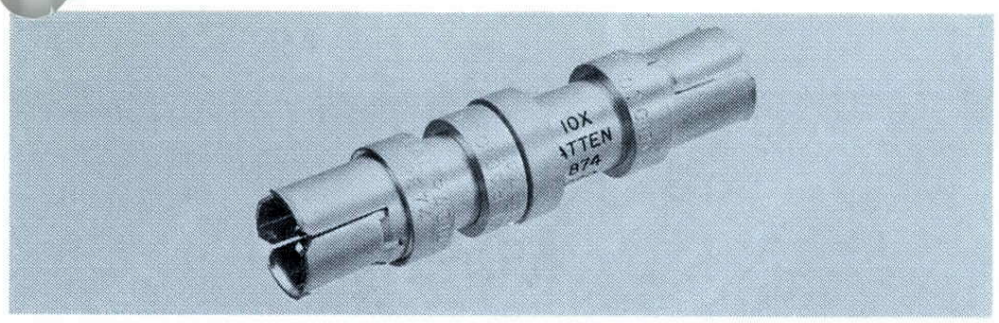
Accessory Housing without electrical components, useful for applications requiring special circuitry.

Order 011-0080-00 ..... $6.60

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Accessories With GR Connectors

ATTENUATORS—TERMINATIONS

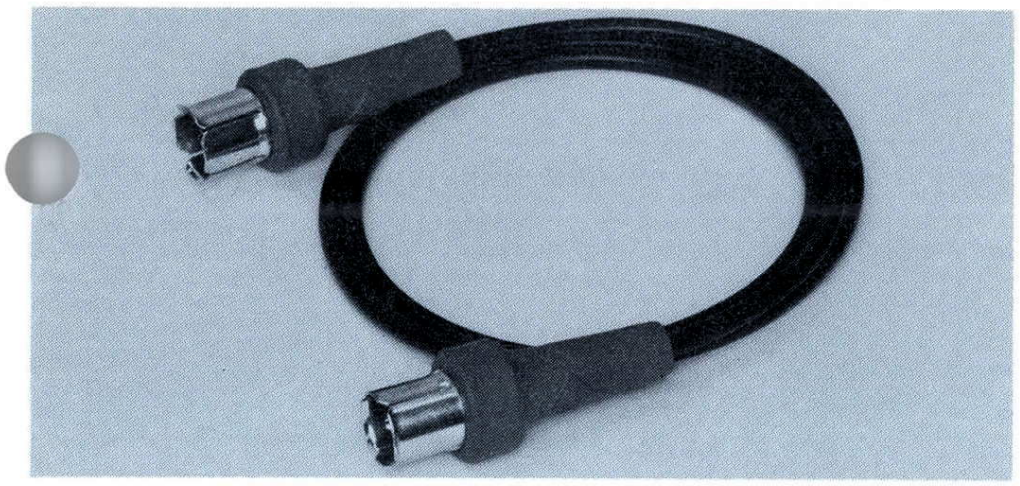


DESCRIPTION	PART NUMBER	PRICE
50-Ω termination, thru-line *(GR to BNC Male)	017-0083-00	$31.00
50-Ω termination, end-line	017-0081-00	28.00
50-Ω 2X attenuator	017-0080-00	33.00
50-Ω 5X attenuator	017-0079-00	33.00
50-Ω 10X attenuator	017-0078-00	33.00
125-Ω min loss	017-0052-00	33.00

CHARACTERISTICS

Accuracy of indicated attenuation ratio is ±2% at DC, ±3% at 1 GHz. Voltage standing wave ratio (VSWR) is less than 1.1 up to 1 GHz. Power Rating is 1 watt.
*Upper frequency limit 100 MHz

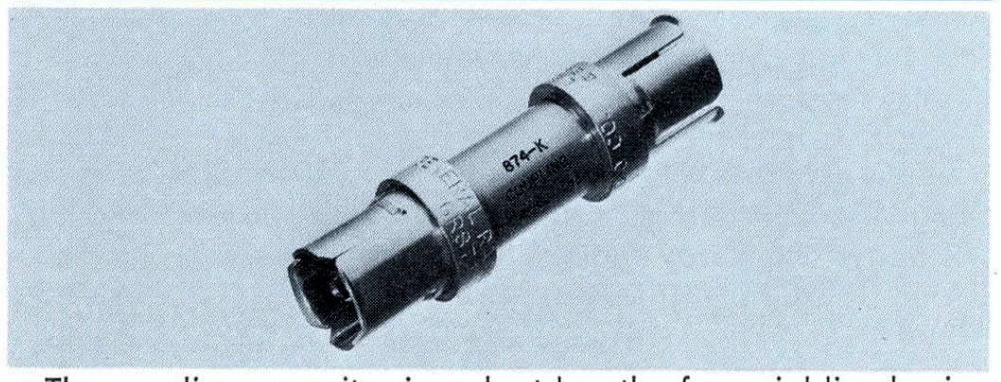
50-OHM CABLES



DESCRIPTION	PART NUMBER	PRICE
Coaxial 1-ns Type RG58C/U*	017-0503-00	$ 9.00
Coaxial 2-ns Type RG58C/U	017-0505-00	15.00
Coaxial 5-ns Type RG213/U	017-0502-00	15.00
Coaxial 5-ns Type RG58C/U	017-0512-00	15.00
Coaxial 10-ns Type RG58C/U	017-0501-00	15.00
Coaxial 20-ns Type RG213/U	017-0504-00	18.00

*Connector on one end only.

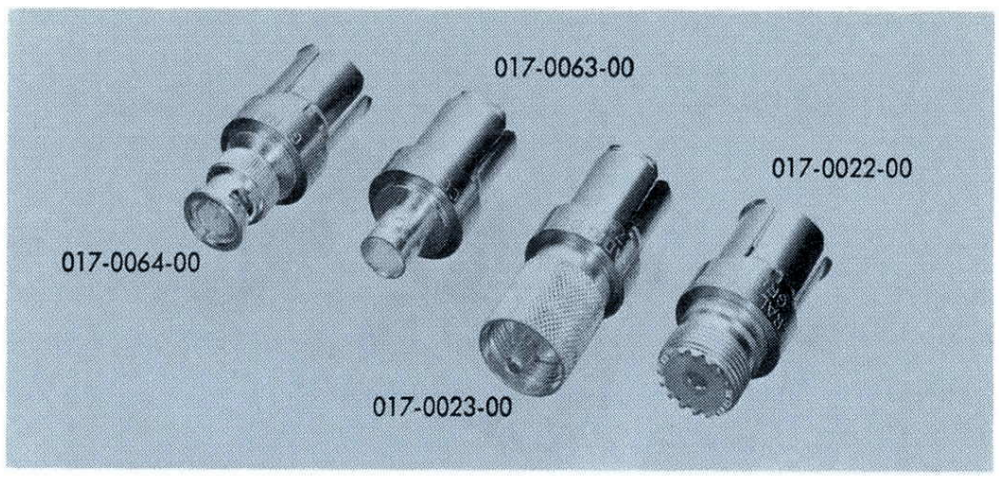
COUPLING CAPACITOR



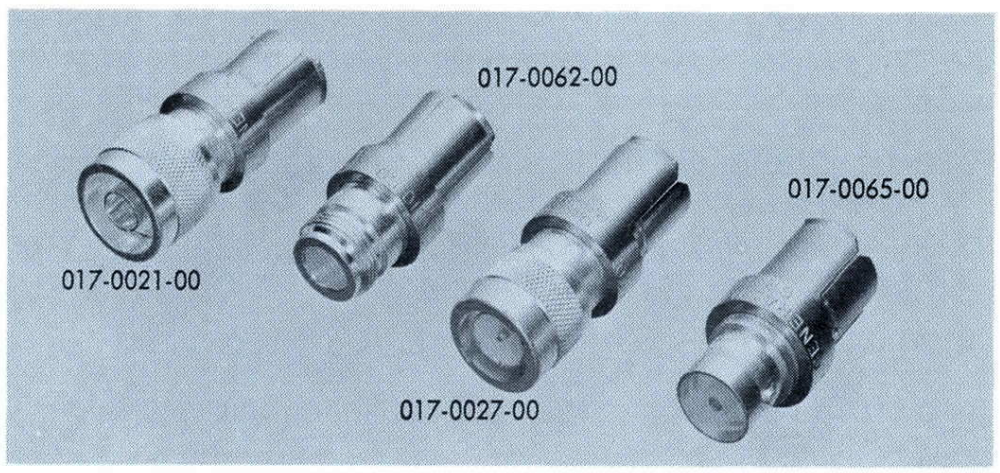
The coupling capacitor is a short length of coaxial line having disk capacitor (4700 pF) in series with the inner connector. High frequencies are transmitted with small reflections, but DC and low frequencies are blocked. Voltage rating is 500 V.

Order 017-0028-00 ..... $12.00

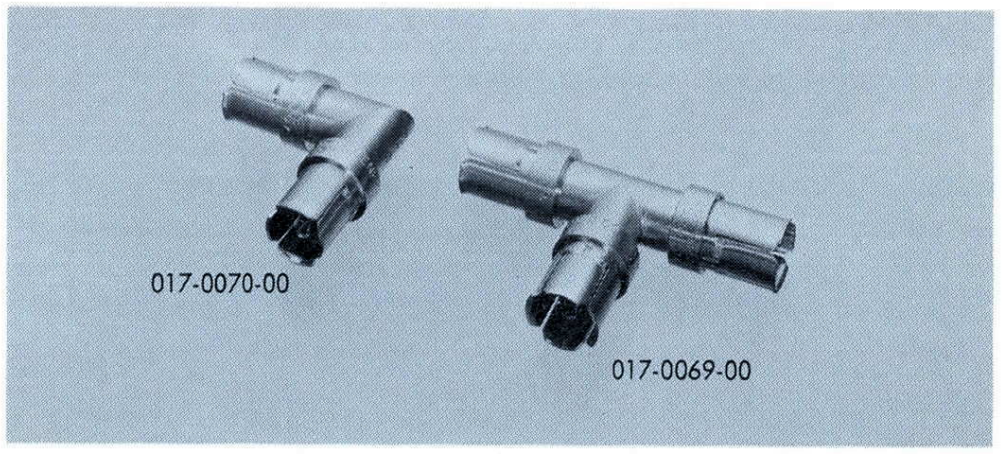
ADAPTERS



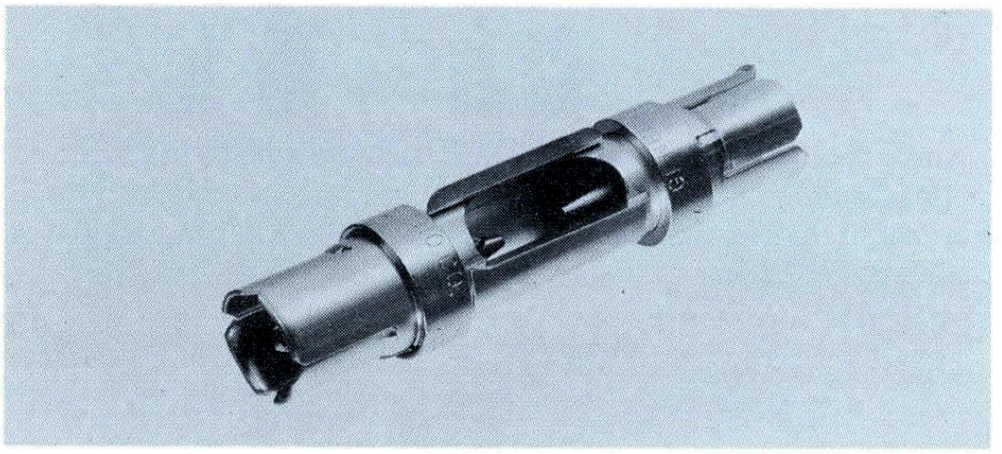
DESCRIPTION	PART NUMBER	PRICE
GR to BNC Male	017-0064-00	$ 8.00
GR to BNC Female	017-0063-00	6.00
GR to UHF Male	017-0023-00	6.00
GR to UHF Female	017-0022-00	6.50



GR to N Male	017-0021-00	$ 7.00
GR to N Female	017-0062-00	6.00
GR to C Male	017-0027-00	8.00
GR to C Female	017-0065-00	8.50



GR Elbow	017-0070-00	$14.00
GR T	017-0069-00	17.00

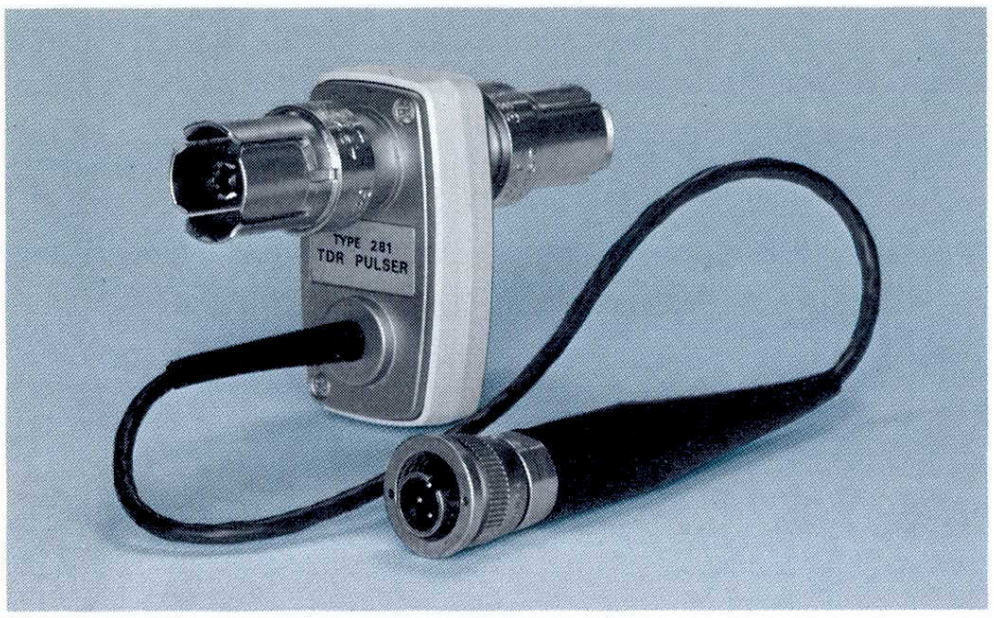


GR Insertion Unit	017-0030-00	$17.75

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Accessories With GR Connectors

TDR PULSER



The Type 281 Time-Domain Reflectometer Pulser is designed for use with Tektronix Type 1S1 and 3S1 Sampling Plug-Ins. It converts these general-purpose sampling plug-ins to an easy-to-use TDR system. Power is obtained from their probe power connector.

FEED-THROUGH OUTPUT allows Type 281 to be connected directly between oscilloscope input and TDR test-line. Pulse injection is from non-loading current source ($\leq$10% capacitive reflection of 750-ps step). GR874 connectors.

RISETIME is less than or equal to 750 ps at negative transition.

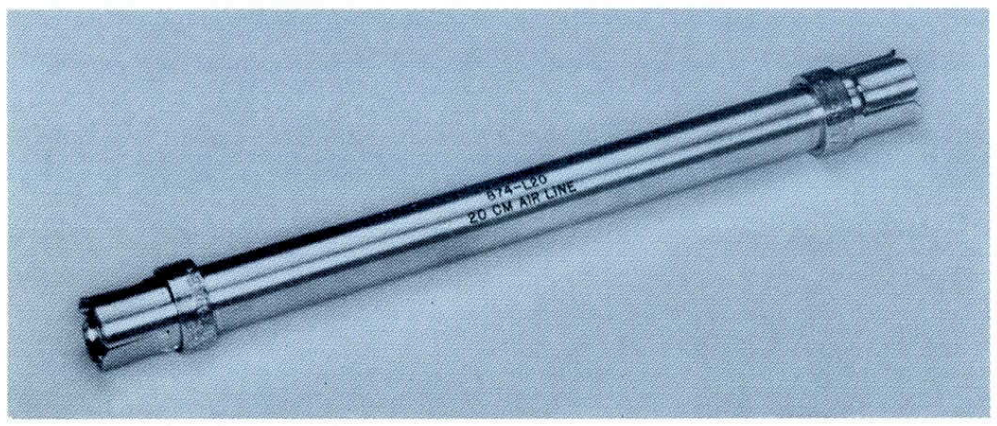
AMPLITUDE is approximately 460 mV (both connectors terminated in 50 Ω).

WIDTH is greater than or equal to 5 μs from negative-going edge to positive-going edge, at 50% amplitude points.

ABERRATIONS are ±2% or less in first 10 ns following the negative transition, ±0.5% after 10 ns.

TYPE 281 TDR PULSER, order 015-0060-00 . . . . . **$95**
Each instrument includes: 2—instruction manuals (070-0515-00).

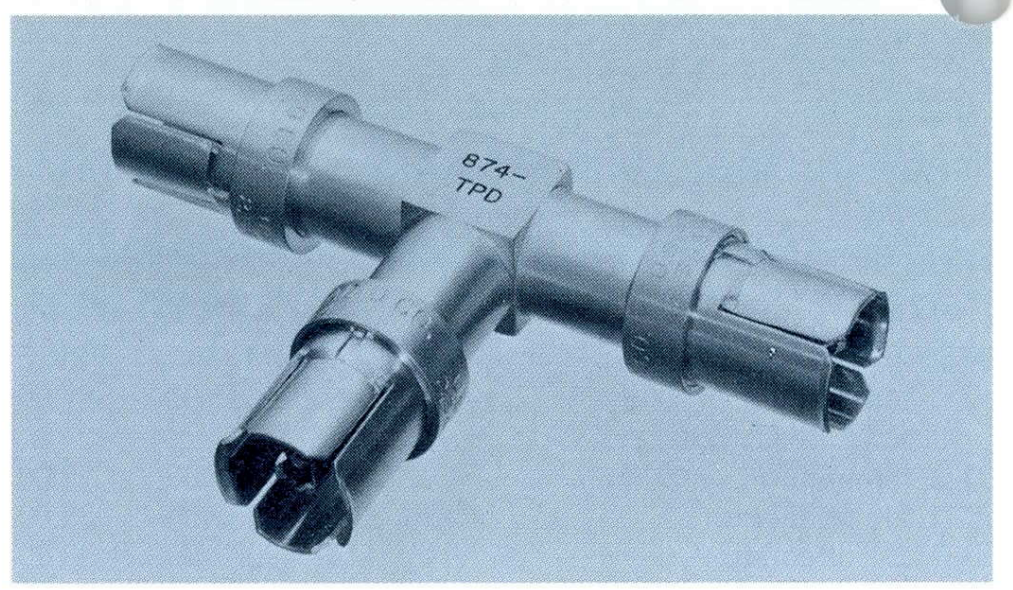
50-OHM AIR LINE



The 20-cm 50-Ω air line is useful as a time-delay device and as an absolute impedance in a time-domain reflectometer system. The characteristic impedance is 50 Ω ±0.4%. Time delay is 0.6698 ns ±0.4%.

Order 017-0084-00 . . . . . $14.00

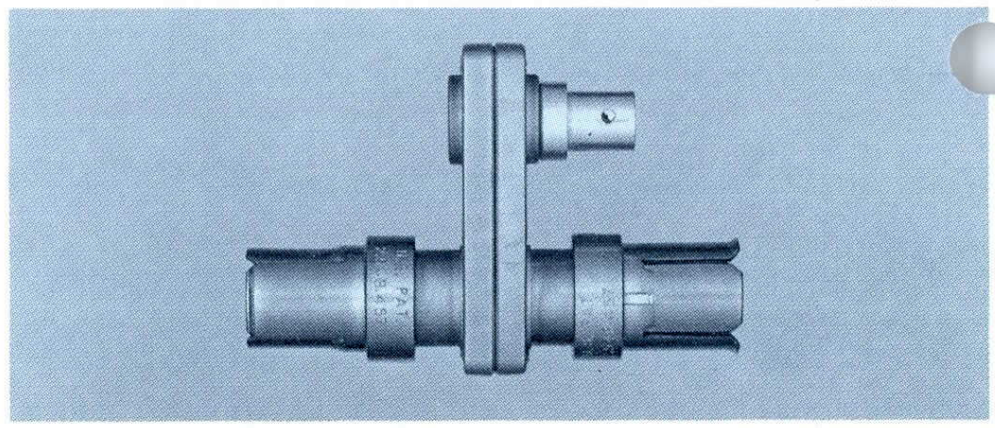
50-OHM POWER DIVIDER



This coaxial tee has a 16.67-ohm resistor in each leg, connected so that the tee looks like 50 ohm if two legs are terminated in 50 ohm. It is designed for use in broad-band 50-Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. It is especially useful in a time-domain reflectometer set-up where test line, pulser, and oscilloscope must be coupled with a minimum of reflection-producing discontinuities.

Order 017-0082-00 . . . . . $77.00

CT-3 SIGNAL PICKOFF



Designed for use with high-frequency oscilloscopes, the CT-3 Pickoff provides a convenient means of picking off a signal in a 50-ohm system. Used with any of the Tektronix sampling instruments, the CT-3 provides the link for use as a trigger source.

SENSITIVITY is 10% of the voltage under test, into a 50-ohm load.

DECAY TIME CONSTANT is 4.5 μs at 0 DC current.

RISETIME is less than 0.4 ns.

FREQUENCY RESPONSE is 50 kHz to 875 MHz at 0 DC current.

INSERTION IMPEDANCE with a 50-ohm termination is 1 ohm shunted by 4.5 μH; 2 ohms shunted by 4.5 μH without a 50-ohm termination.

VSWR is less than 1.2 at 1.5 GHz.

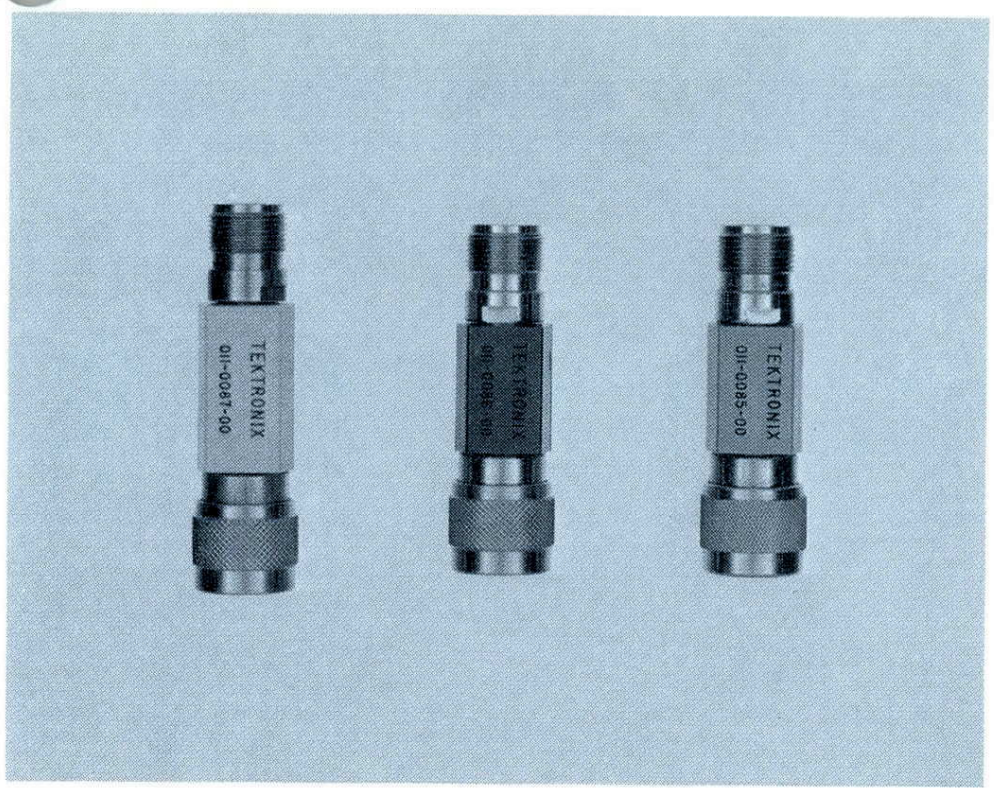
VOLTAGE RATING at 0 V DC is 25 V RMS, 1-kV pulse peak. The volts-second product is 100 V μs. If exceeded, the L/R decay will decay rapidly toward zero.

Order 017-0061-00 . . . . . $38.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Accessories With N Connectors

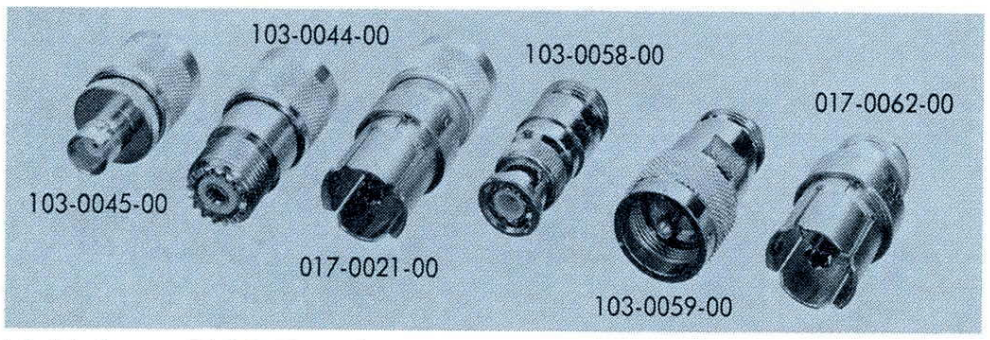
50-OHM ATTENUATORS



Frequency range is DC to 12.4 GHz. Power rating is 2 W average, 300 W peak. Impedance is 50 Ω.

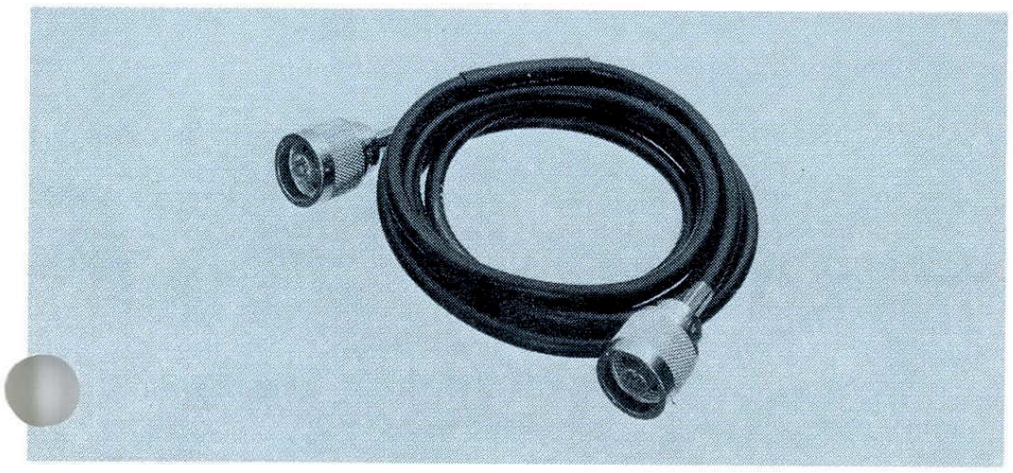
DESCRIPTION	PART NUMBER	PRICE
10-dB attenuator	011-0085-00	$45.00
20-dB attenuator	011-0086-00	$45.00
40-dB attenuator	011-0087-00	$55.00

ADAPTERS



N Male to BNC Female	103-0045-00	$2.40
N Male to UHF Female	103-0044-00	3.90
N Male to GR	017-0021-00	7.00
N Female to BNC Male	103-0058-00	2.40
N Female to UHF Male	103-0059-00	2.50
N Female to GR	017-0062-00	6.00

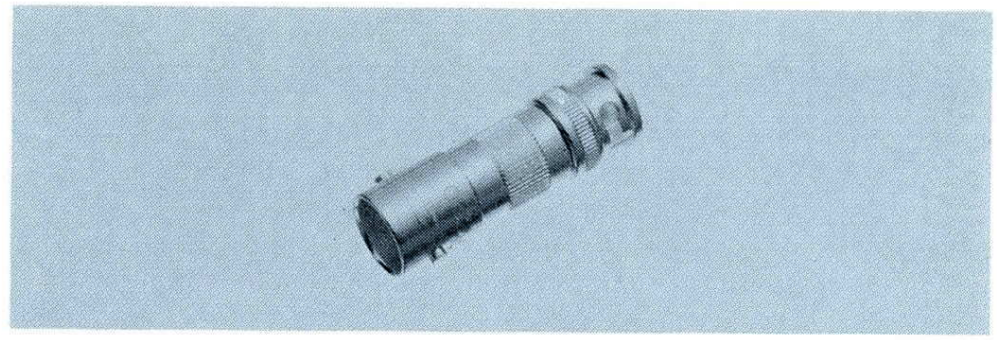
50-OHM CABLE



Coaxial Type N connectors, 6 feet, order 012-0114-00... $9.80

Accessories With BSM Connectors

ADAPTER

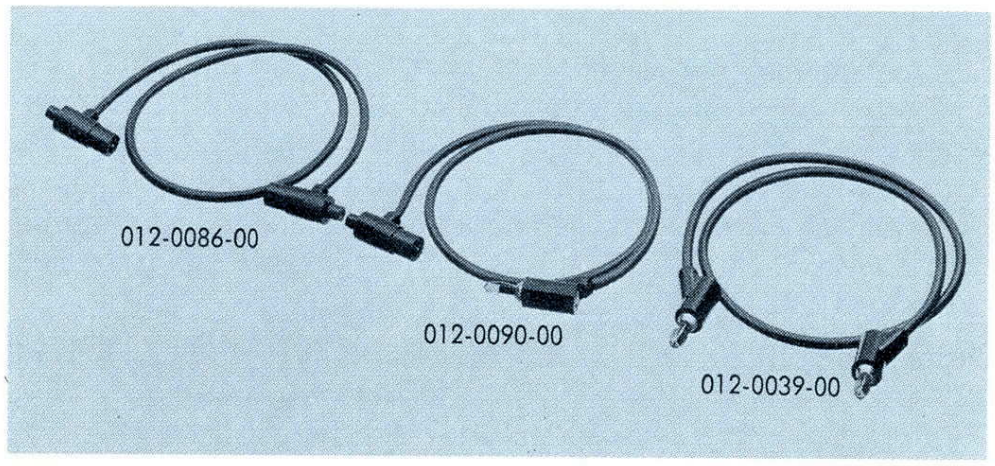


DESCRIPTION	PART NUMBER	PRICE
BSM Male to BNC Female	103-0036-00	$5.50

50-OHM CABLES

Coaxial, 7 inch, RG58 BSM Female to BNC Male	012-0128-00	$5.50
Coaxial, 18 inch, RG58 BSM Female to BNC Male	012-0127-00	5.50

PATCH CORDS



BNC to BNC, 18 inch
- Red, order 012-0087-00 ..... $1.65
- Black, order 012-0086-00 ..... $1.65

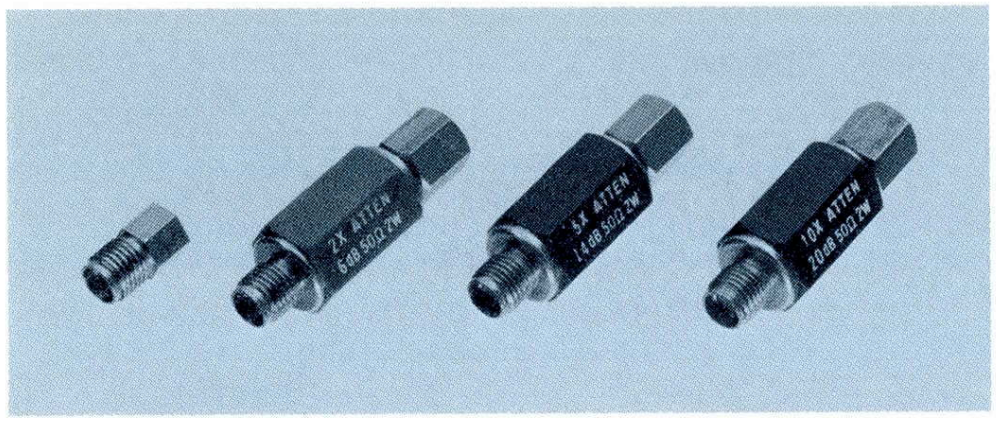
BNC to banana plug-jack, 18 inch
- Red, order 012-0091-00 ..... $1.65
- Black, order 012-0090-00 ..... $1.65

Banana plug-jack to banana plug-jack, 18 inch
- Red, order 012-0031-00 ..... $1.65
- Black, order 012-0039-00 ..... $1.65

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Accessories With 3-mm Connectors

ATTENUATORS — TERMINATORS

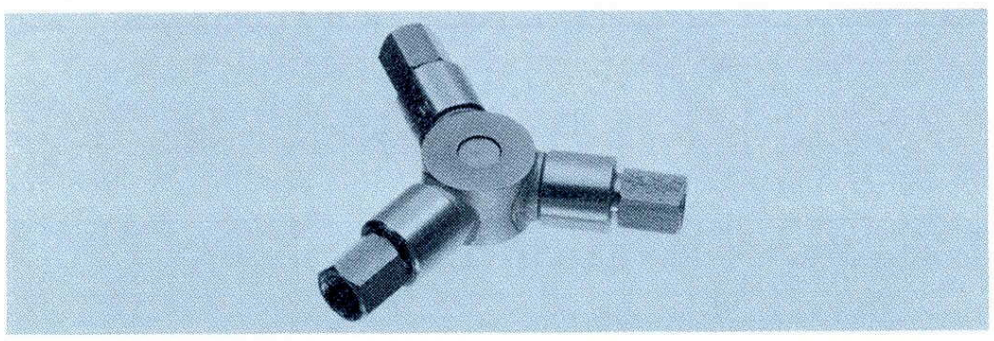


DESCRIPTION	PART NUMBER	PRICE
50-Ω termination	015-1004-00	$ 40
50-Ω 2X attenuator	015-1001-00	66
50-Ω 5X attenuator	015-1002-00	77
50-Ω 10X attenuator	015-1003-00	72

CHARACTERISTICS

	DC — 12.40 GHz		12.41 — 18.00 GHz		Power
	Attenuation Accuracy	VSWR	Attenuation Accuracy	VSWR	Continuous
Termination	±1 Ω	1.15	±1 Ω	1.15	.5 W
2X (6 dB)	± .75 dB	1.40	±1.00 dB	2.00	1 W
5X (14 dB)	± .75 dB	1.40	±1.00 dB	1.60	1 W
10X (20 dB)	± .75 dB	1.40	±1.00 dB	1.60	1 W

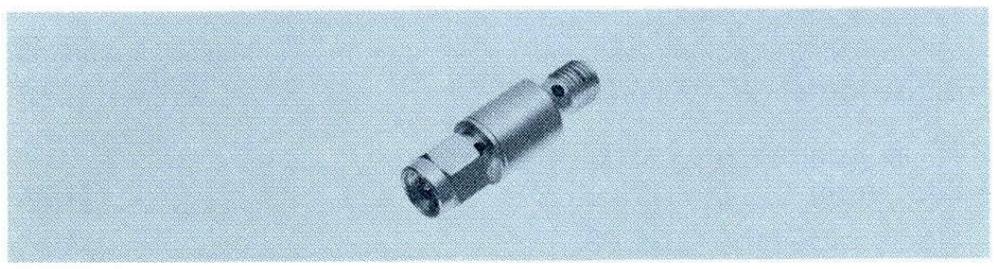
50-Ω POWER DIVIDER



This coaxial tee is designed for use in broad-band, 50-Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. Load isolation is nominally 6 dB while the voltage attenuation ratio is nominally 2X (input to either load arm, other load arm) terminated in a standard 50-Ω termination. Maximum VSWR is 1.35 from DC to 12.00 GHz and 1.70 from 12.01 to 18.00 GHz.

Order 015-1014-00 ..... $ 94

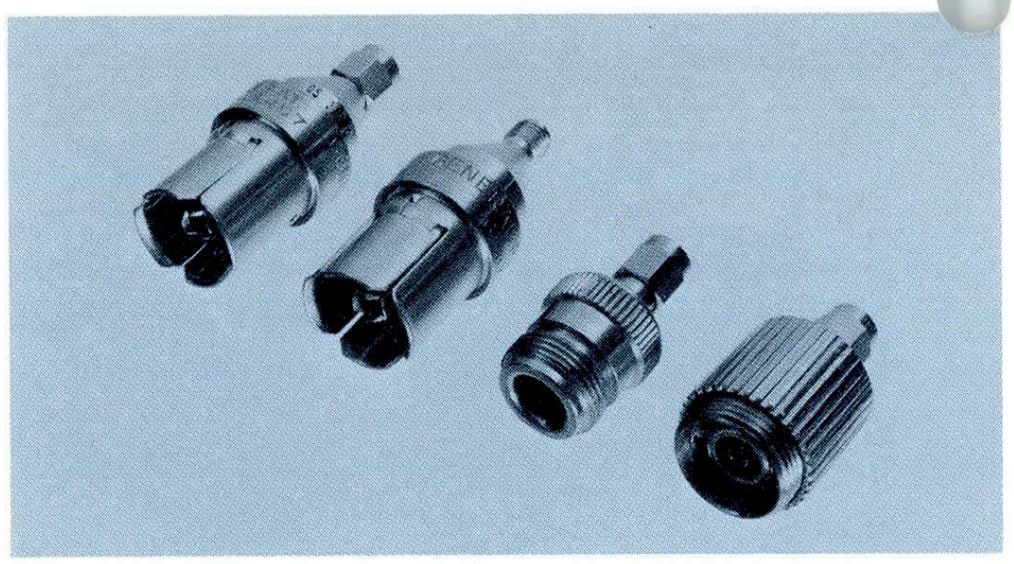
50-Ω COUPLING CAPACITOR



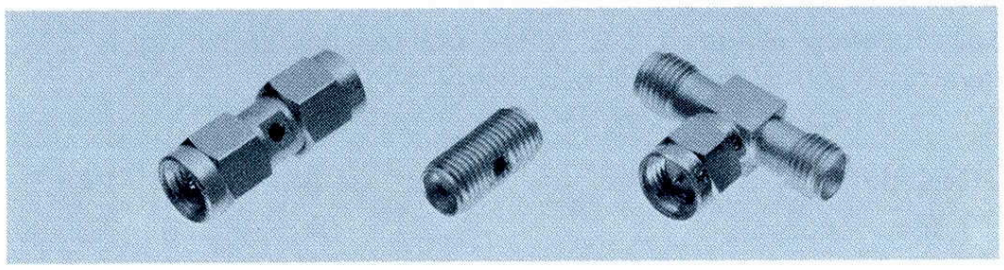
The coupling capacitor is a short length of coaxial line having a disc capacitor (4700 pF, ±20%) in series with the inner conductor. Reflection ratio (in 150-ps TDR system), maximum is 0.03. Voltage rating is 200 Volts.

Order 015-1013-00 ..... $ 75

ADAPTERS

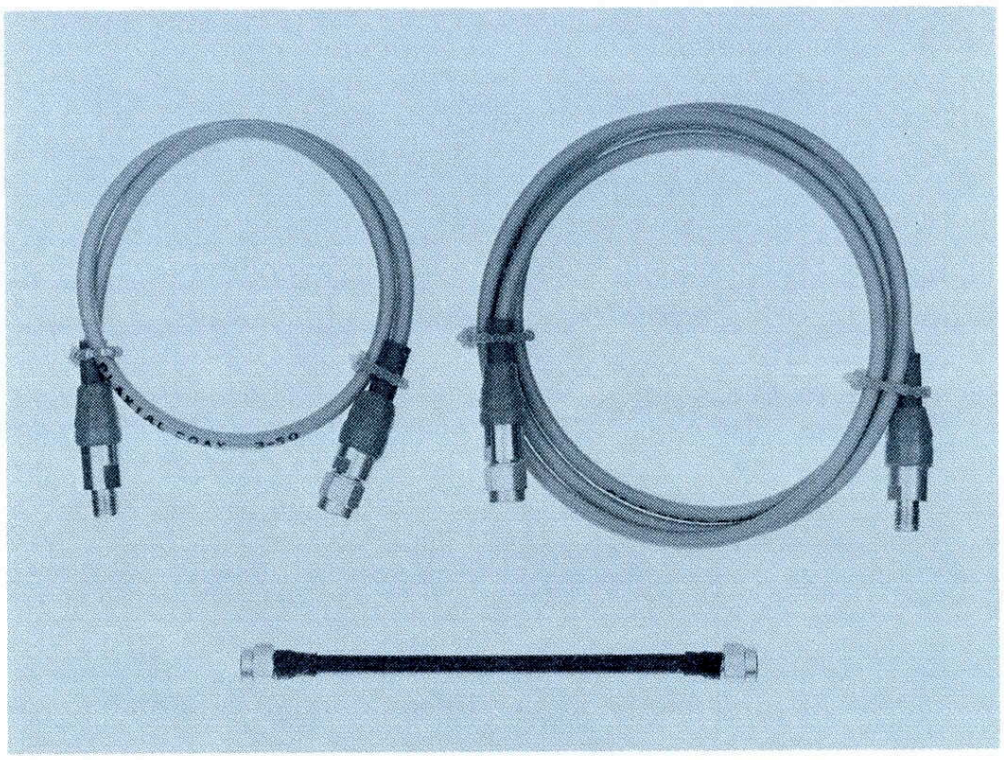


DESCRIPTION	PART NUMBER	PRICE
3-mm Male to GR874	015-1007-00	$ 20
3-mm Female to GR874	015-1008-00	20
3-mm Male to N Female	015-1009-00	40
3-mm Male to 7-mm APC	015-1010-00	105



3-mm Male to 3-mm Male	015-1011-00	$ 9
3-mm Female to 3-mm Female	015-1012-00	
3-mm T	015-1016-00	

50-Ω CABLES

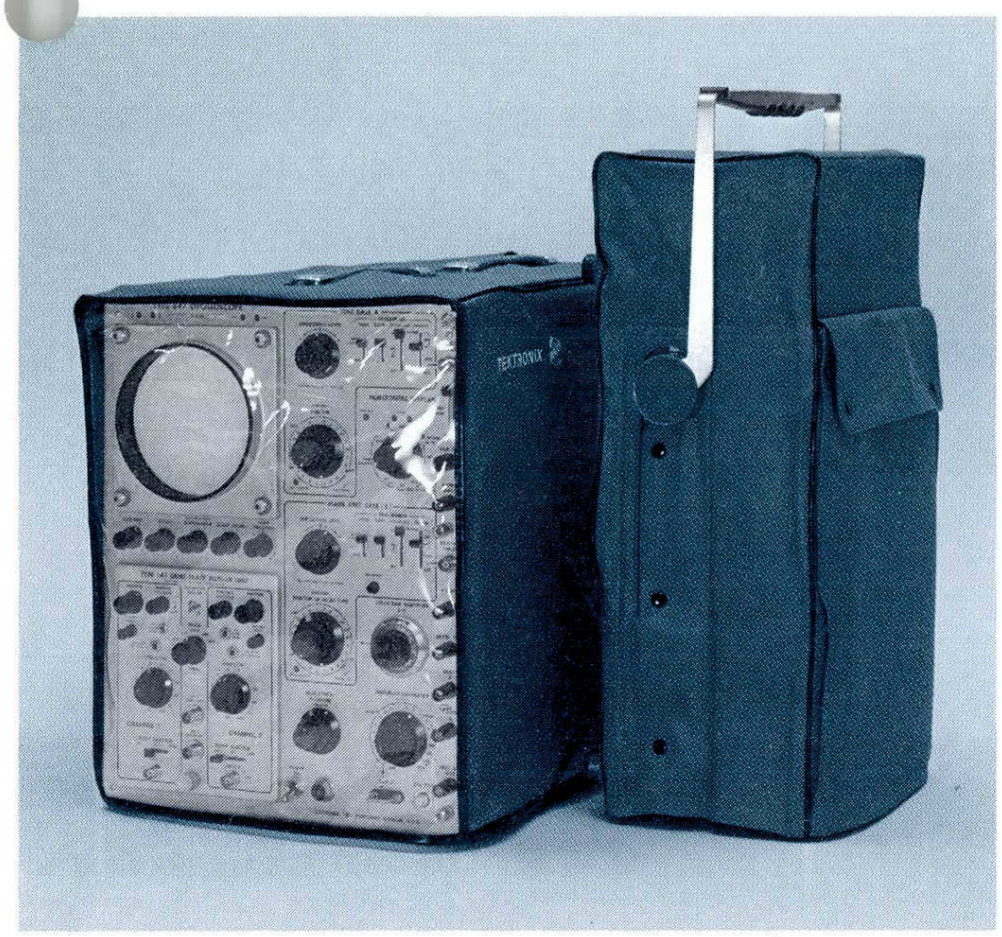


DESCRIPTION	PART NUMBER	PRICE
Coaxial semirigid 500 ps	015-1015-00	$ 24
Coaxial 2 ns	015-1005-00	40
Coaxial 5 ns	015-1006-00	

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Instrument Covers, Cases

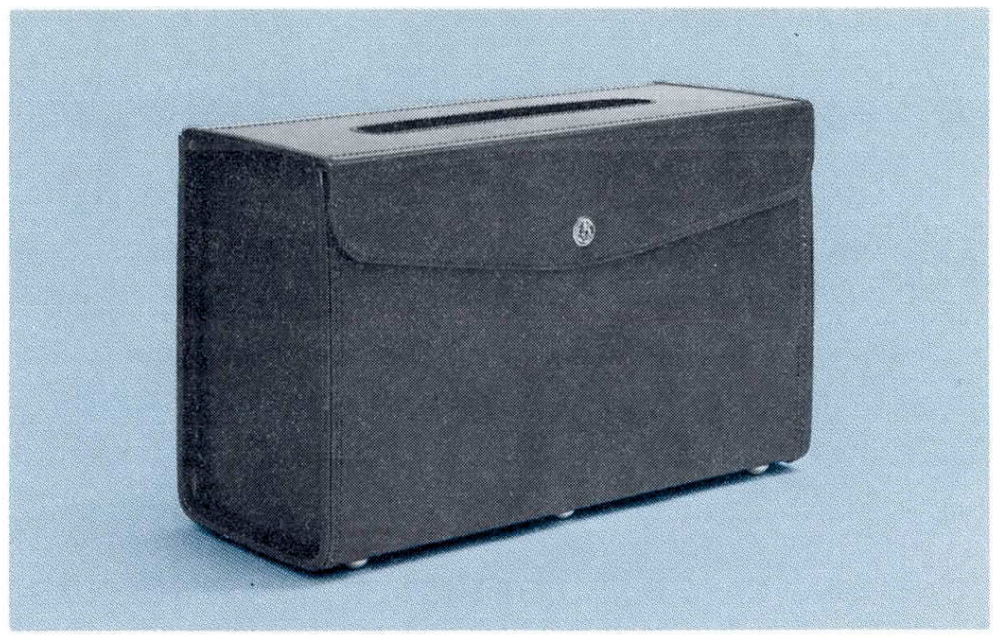
OSCILLOSCOPE DUST COVERS



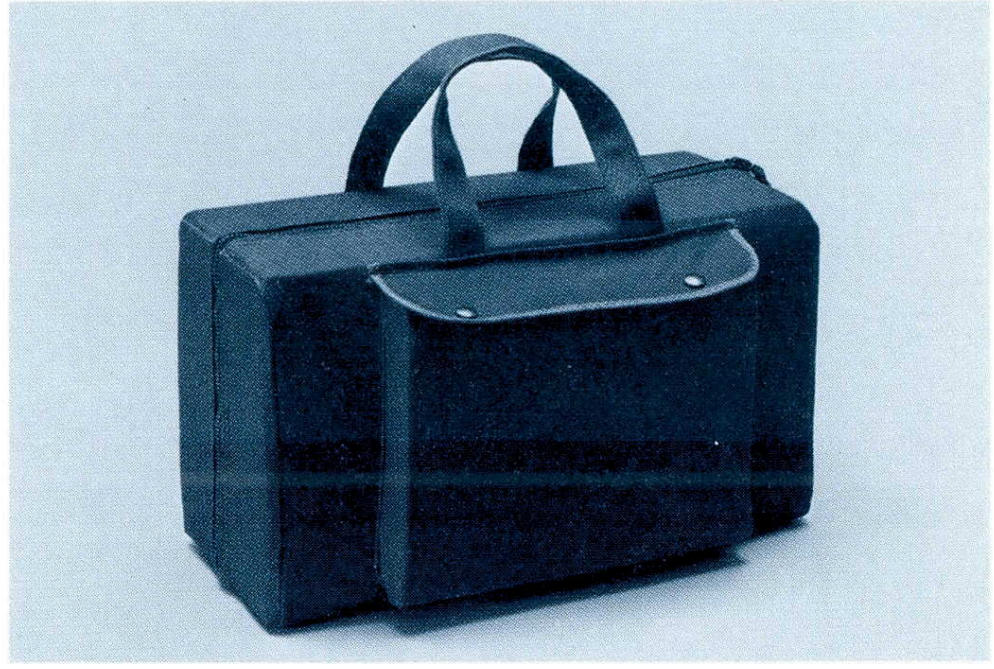
The dust cover provides protection for the oscilloscope during transport or storage. Made of water-proof blue vinyl, the covers are available for both laboratory and portable instruments. The laboratory version features a clear frontal area for easy identification of the instrument. The cover for all portable instruments except the Type 323 has a pocket for carrying the manual.

INSTRUMENT	PART NUMBER	PRICE
Type 323	016-0112-00	$8.00
Type 422 (with battery pack)	016-0075-00	8.00
Type 422 (without battery pack)	016-0076-00	8.00
Type 453, 454, 491	016-0074-01	8.00
Type 502A	016-0070-00	8.00
Type 529 (with field case)	016-0085-00	8.00
Type 503, 504, 515A, 516, 647A; 560-Series (except Type 565, 567, 568)	016-0067-00	8.00
Type 565, 567, 568	016-0069-00	8.00
Type 530-, 540-, 550-, and 580-Series (except Type 555 and 556)	016-0068-00	8.00

OSCILLOSCOPE CARRYING CASES



CARRYING CASE—For Type 321A Portable Oscilloscope.
Order 016-0026-00 ..... $44.00

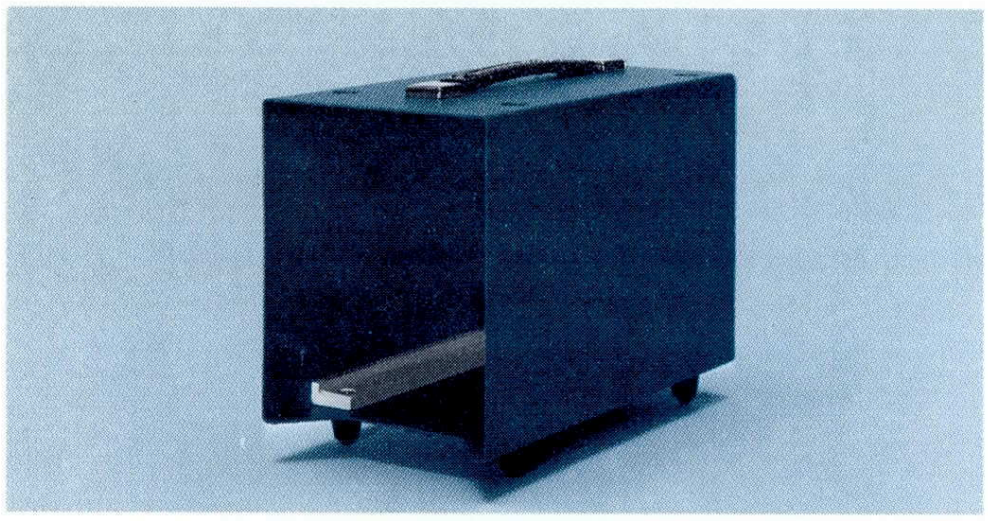


CARRYING CASE—For Type 310A Oscilloscope. Made of sturdy, turquoise-colored canvas.
Order 016-0028-01 ..... $22.00

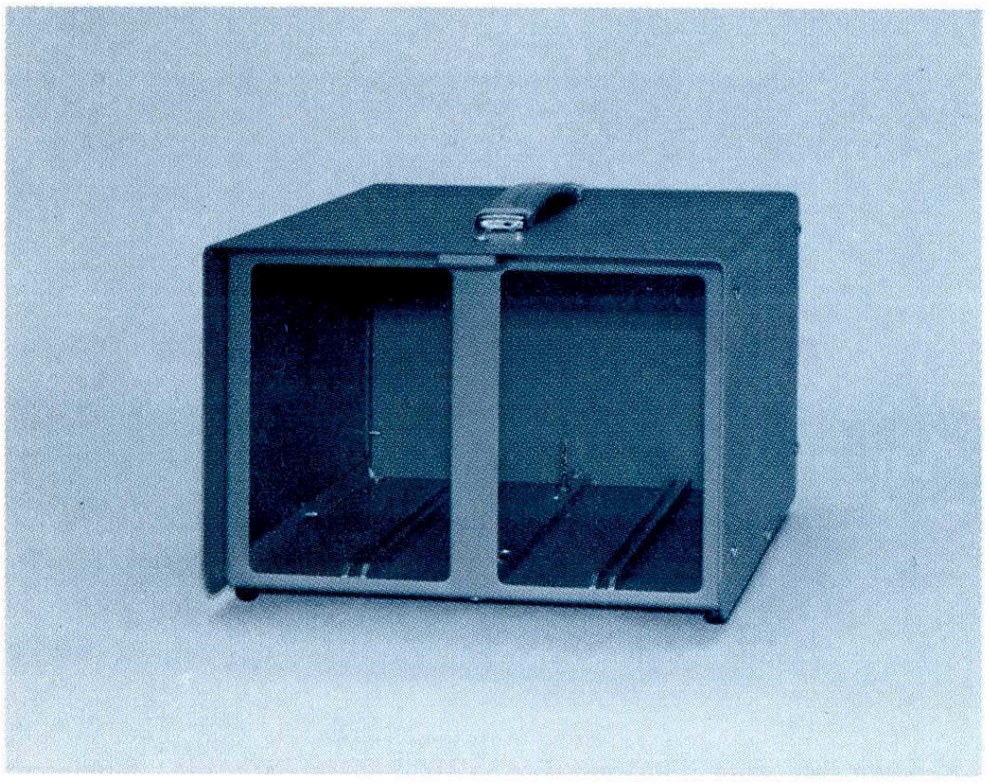
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Carrying Cases

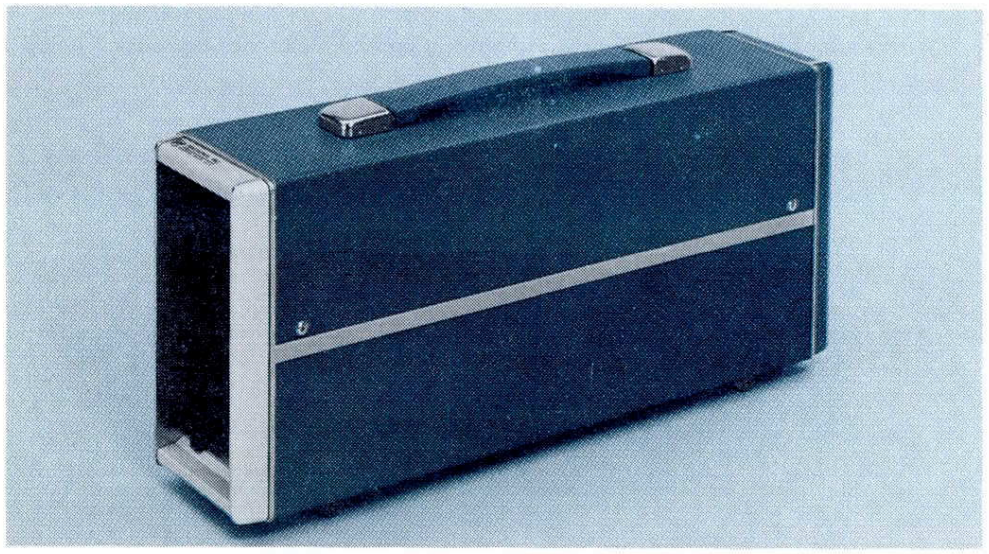
PLUG-IN UNIT CARRYING CASES



CARRYING CASE FOR LETTER-SERIES OR 1-SERIES PLUG-IN UNITS—Provides protection for one oscilloscope plug-in unit.
Order 437-0065-00 ..... $22

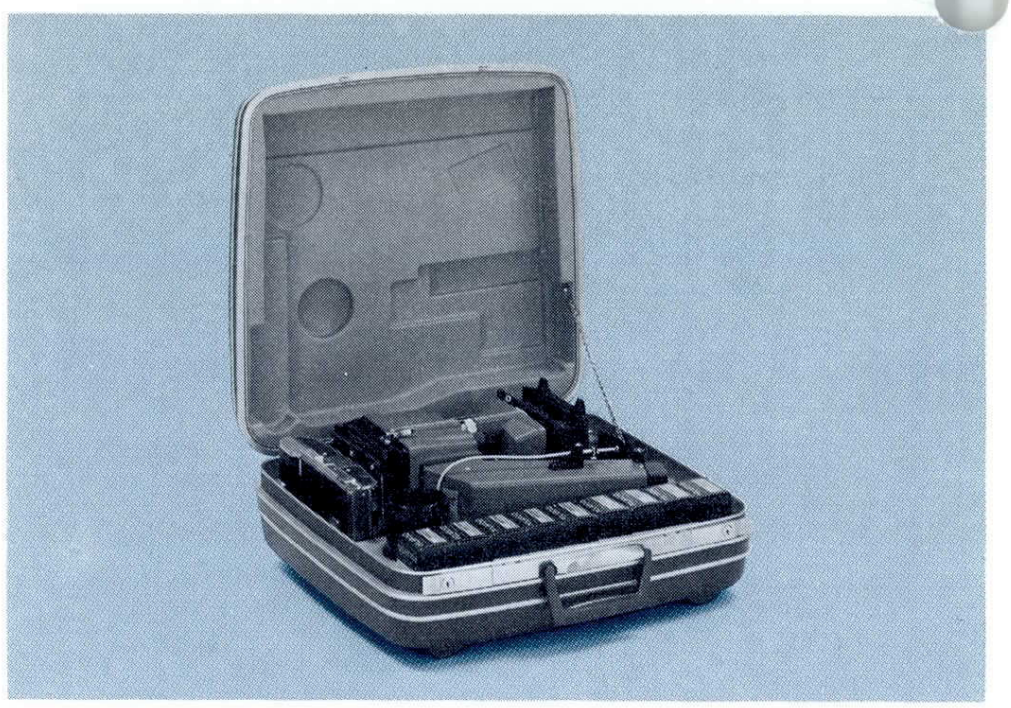


CARRYING CASE FOR 2, 3, 10 and 11-SERIES PLUG-IN UNITS—accommodates two plug-in units.
Order 437-0070-00 ..... $22



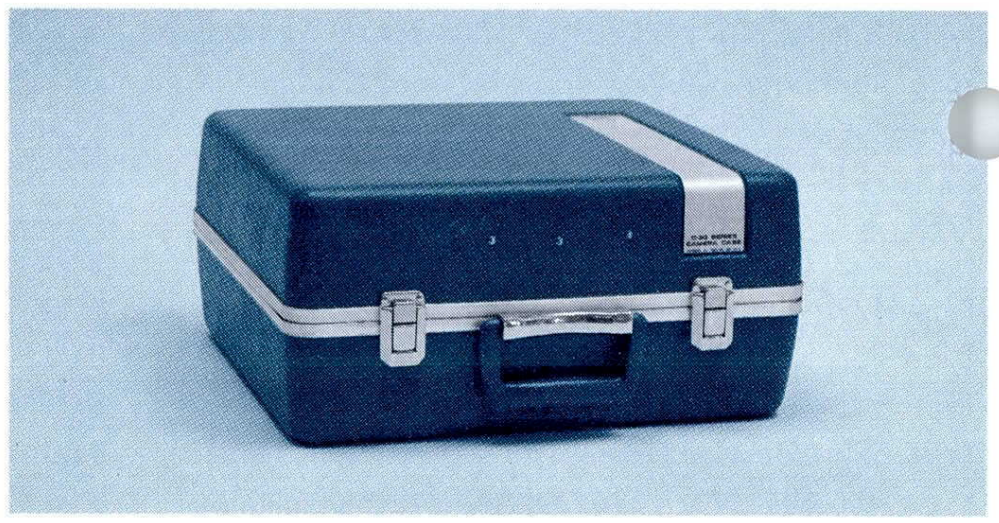
CARRYING CASE FOR 7000-SERIES PLUG-IN UNITS
Order 437-0106-00 ..... $30

CAMERA CARRYING CASES



C-12/C-27 CARRYING CASE—C-12/C-27 Camera Carrying Case holds either the C-12 or C-27 Camera and all the standard accessories plus extra film. The case is constructed of heavy-gage, high-impact plastic and has a foam-rubber liner. Dimensions are 20½ by 20 by 8 inches. Net weight is 18¼ pounds; domestic shipping weight is ≈22 pounds.

Order 016-0208-01 ..... $85



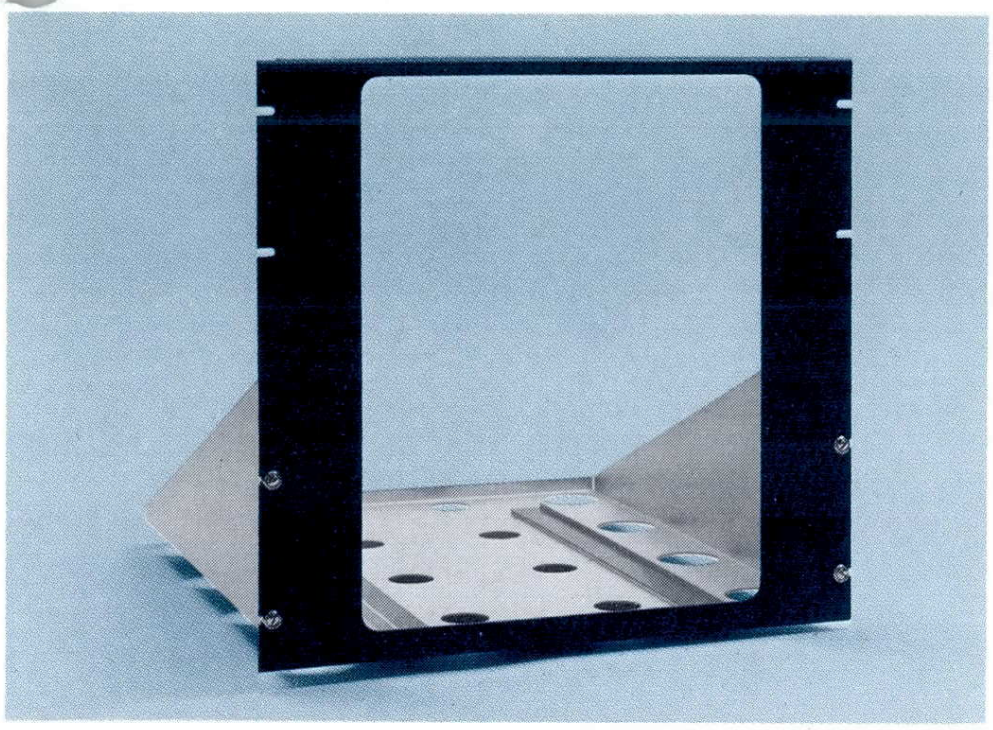
C-30A/C-31 CARRYING CASE—The carrying case holds the C-30A or C-31 Camera and all standard accessories including up to three Film Backs, extra bezels and extra film. The case is constructed of heavy-gage, high-impact plastic and has a vacuum-formed styrene liner. Dimensions are $7\frac{3}{16} \times 13\frac{3}{16} \times 15\frac{3}{16}$ inches.

Order 016-0126-00 ..... $38

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Mounting Accessories

CRADLE MOUNTS



CRADLE-MOUNT—For rackmounting cabinet-type oscilloscopes. Each cradle-mount consists of a cradle (or "shelf") to support the instrument in any standard 19-inch relay rack, and a mask to fit over the regular instrument panel. Blue vinyl finish.

For Type 530-, 540-, and 580-Series, Type 575 (1 mask, 1 cradle). Rack-height requirements 17½ inches. Depth is 21 9/16 inches.
Order 040-0281-00 ..... $34.50

For Type 551 Oscilloscope (2 masks, 2 cradles). Rack-height requirements: Indicator mask 17½ inches, Power Supply mask 12¼ inches. Depth is 21 9/16 inches.
Order 040-0279-00 ..... 83.00

For Type 515A and Type 516 instruments (1 mask, 1 cradle). Rack-height requirements 15¾ inches. Depth is 21 9/16 inches.
Order 040-0277-00 ..... 34.50

For Type 502A instruments (1 mask, 1 cradle). Rack-height requirements 17½ inches. Depth is 21 9/16 inches.
Order 040-0278-00 ..... 34.50

For Types 503, 504, 561B, 564B instruments (1 mask, 1 cradle). Rack-height requirements 15¾ inches. Depth is 21 9/16 inches.
Order 040-0321-01 ..... 34.50

MOUNTING FRAME—Holds four of any combination of Type FM122, Type 360, or Type 160-Series units. Mounts to standard 19-inch instrument rack.
Order 014-0002-00 ..... 8.00

BLANK PANEL—Covers space normally occupied by one instrument mounted in the frame.
Order 333-0157-00 ..... 4.40

REAR-SUPPORT CRADLES

CRADLE-ASSEMBLY—Provides rear support for rackmount instruments with slide-out tracks, when mounted in a 19-inch backless rack.

For Types RM15, RM561B, RM564B, RM647A, and Type 127.
Order 040-0344-00 ..... $10.00

For Types RM565 and RM567.
Order 040-0346-00 ..... $10.00

RACK ADAPTER

The Rack Adapter converts the latest series of Tektronix Generators for rackmounting. The rack adapter mounts in a standard 19-inch wide rack and is 5¼ inches high and 17¾ inches deep. Rear mounting brackets can be adjusted for a rear mounting depth of 8½ inches to 26 inches.

Two ½-rack width generators, such as the Type 106 Square-wave Generator, 114 Pulse Generator, or 191 Constant Amplitude Signal Generator can be mounted side by side. Up to four ¼-rack width generators, such as the Type 284 Pulse Generator can be mounted in one rack adapter. Two ¼-rack width instruments may be mounted with a ½-rack instrument.

The Adapter provides forced-air ventilation. Blank panels are available to cover the unused opening when the adapter is not filled. A divider kit is required between instruments, between an instrument and panel, and between panels. Blank panels and divider kits are not included with the Rack Adapter.

RACK ADAPTER (016-0086-01) $135.00

¾-WIDTH BLANK PANEL (016-0133-00) ..... $ 9.00

½-WIDTH BLANK PANEL (016-0081-00) ..... $ 8.00

¼-WIDTH BLANK PANEL (016-0109-00) ..... $ 5.50

DIVIDER KIT (016-0089-00) ..... $ 11.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Mounting Accessories

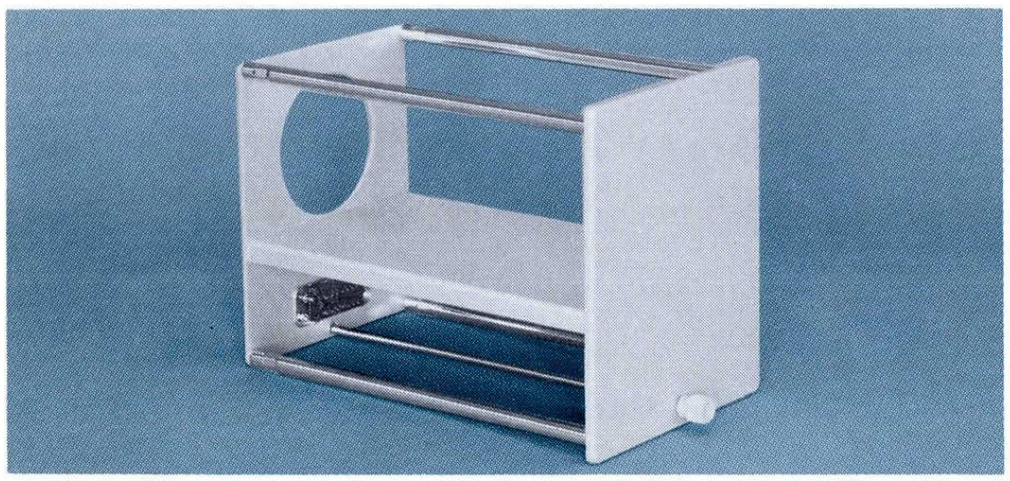
STORAGE CABINETS

PLUG-IN PREAMPLIFIER STORAGE CABINET mounts in standard 19-inch rack, available in two types:

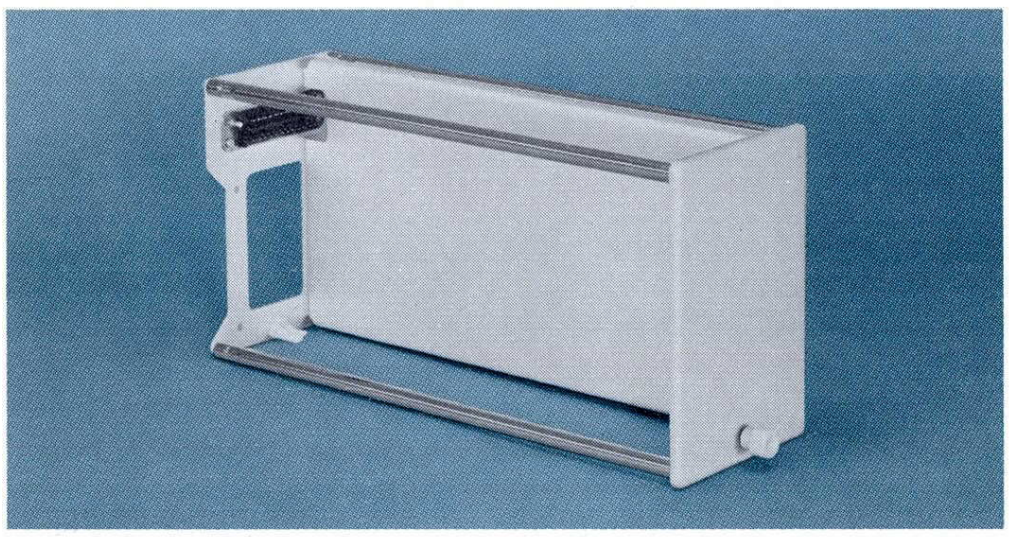
FOR 1-SERIES AND LETTER-SERIES PLUG-IN UNITS—holds 3 plug-in units. Measures 19 inches wide, 8¾ inches high, 9⅜ inches deep.
Order 437-0031-00 . . . . . $27.50

FOR 2 AND 3-SERIES PLUG-IN UNITS—holds 4 plug-in units. Measures 19 inches wide, 7 inches high, 13⁵⁄₁₆ inches deep.
Order 437-0071-00 . . . . . $33.00

BLANK PLUG-IN CHASSIS

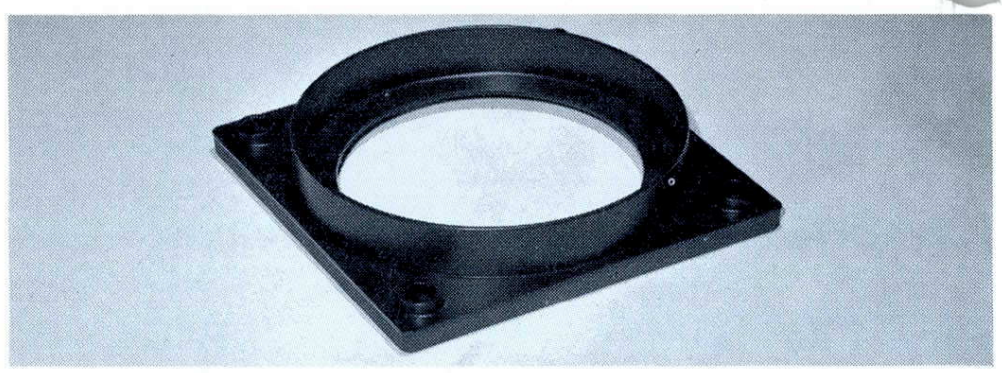


BLANK 1-SERIES AND LETTER-SERIES PLUG-IN CHASSIS—Useful for constructing your own special circuits.
Order 040-0065-00 . . . . . $27.50



BLANK TYPE 560-SERIES PLUG-IN CHASSIS—For special circuit construction of sweep or vertical amplifier.
Order 040-0245-00 . . . . . $27.50

CAMERA MOUNTING ADAPTERS

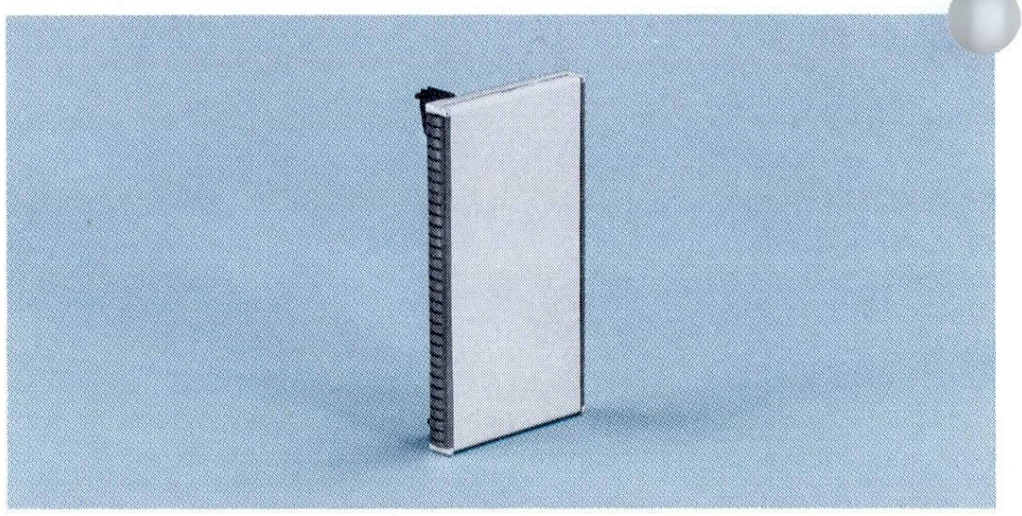


Bezels for mounting commercially available cameras on Tektronix Oscilloscopes. Mounting ring measures 5⅝-inches outside diameter. Die-cast construction.

INSTRUMENT*	PART NUMBER	PRICE
Type 502A, 503, 504, 515A, 516, 530-, 540-, 550-, 580-Series, 565, 575	014-0018-00	$7.00
Type 561B, 564B, 567, 568	014-0016-00	$8.50
Type 647A	014-0017-00	$8.50
Type 529	014-0031-00	$8.50

*Also rackmount version.

BLANK PLUG-IN PANEL



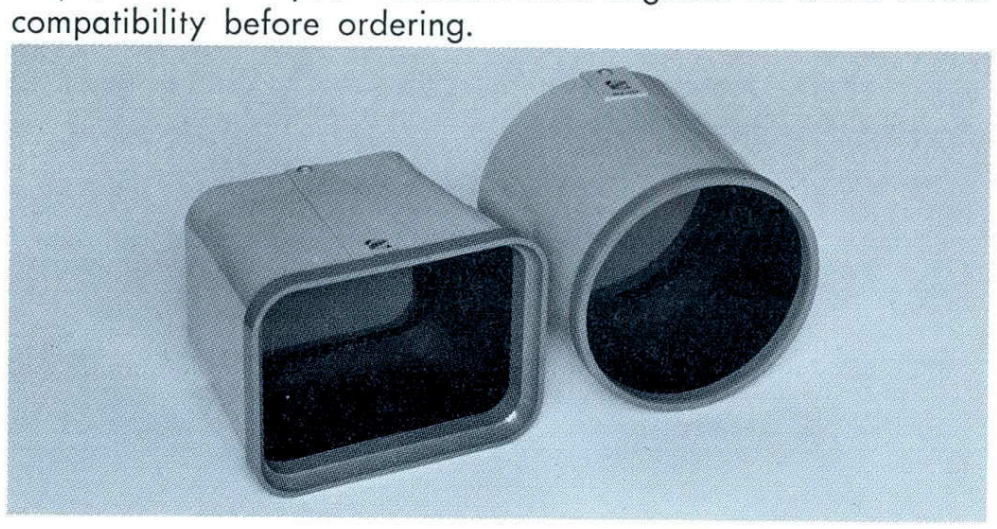
7000-SERIES BLANK PLUG-IN PANEL—When operating the 7000-Series instruments with less than the full complement of plug-ins (4), the blank plug-in panel may be used to cover unused channels.
Order 016-0155-00 . . . . . $6.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Viewing Accessories

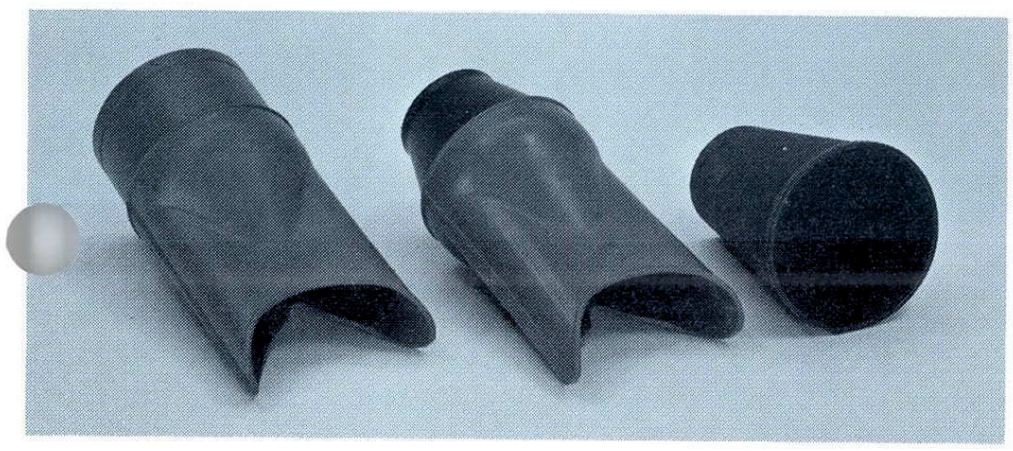
VIEWING ACCESSORIES

The viewing accessories listed normally mount on the oscilloscope graticule cover. In many cases, they will also fit camera-mounting bezels. If you intend using a camera on your oscilloscope, check with your Tektronix Field Engineer for bezel-viewer compatibility before ordering.



POLARIZED VIEWERS—For Tektronix 5-inch Oscilloscopes. The viewers reduce troublesome reflections and glare under high ambient-light conditions.

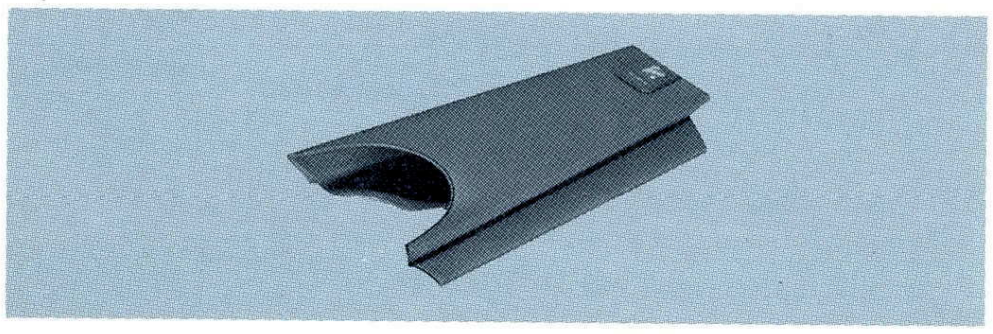
RECTANGULAR VIEWER, order 016-0039-00 . . . $12.00
PLASTIC ROUND VIEWER, order 016-0053-00 . . . $12.00



VIEWING HOOD—For Tektronix 5-inch Oscilloscopes. Includes molded rubber eyepiece and separate tubular light shield.
Order 016-0001-01 ..... $7.00

VIEWING HOOD—For Tektronix 3-inch Oscilloscopes. Includes molded rubber eyepiece and separate tubular light shield.
Order 016-0002-00 ..... $7.00

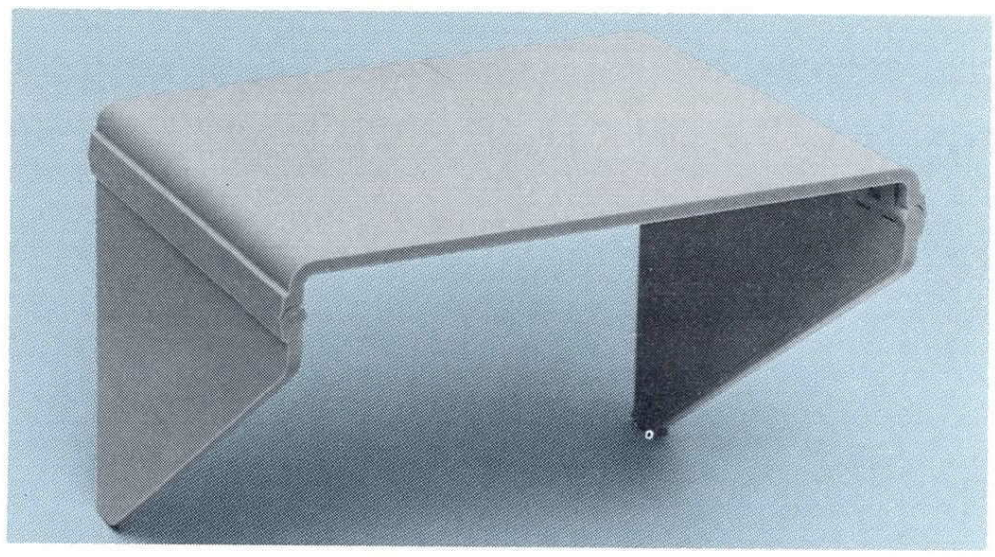
COLLAPSIBLE VIEWING HOOD—For Tektronix 3-inch Oscilloscopes. It is made of black acrylic plastic with handy fastening arrangement.
Order 016-0010-00 ..... $6.00



COLLAPSIBLE VIEWING HOOD—For portable instruments with rectangular CRT's. Blue-vinyl material, folds flat for convenient storage.

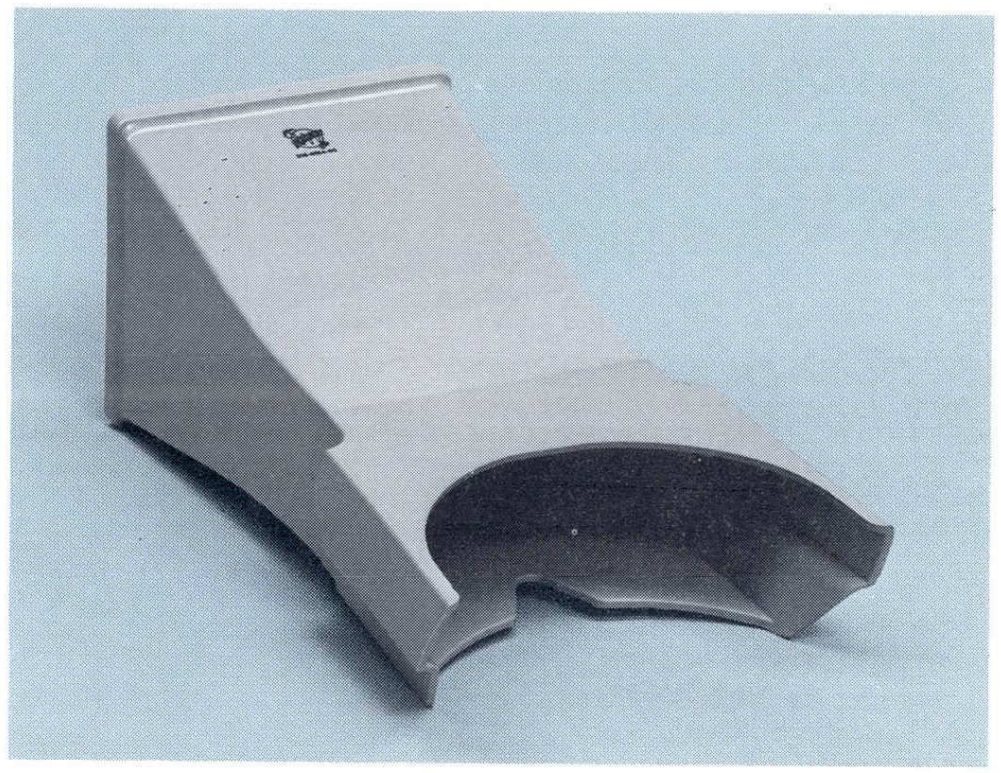
For Types 453, 454, order 016-0083-00 ..... $9.00
For Types 422, 491, order 016-0082-00 ..... $9.00
For Types 549, 561B, 564B, 567, 568, order 016-0103-00 .. $9.00

VIEWING ACCESSORIES



VIEWING HOOD (folding)—for Types 576, 5000 and 7000 Series Oscilloscopes. Molded gray polycarbonate with non-reflective finish.

For Types 576, 5000 Series, order 016-0259-00 ..... $8.00
For 7000 Series, order 016-0260-00 ..... $8.00



VIEWING HOOD—for Type 576, 5000 and 7000 Series Oscilloscopes. Molded gray polystyrene with a polyurethane eyepiece.

For Type 576 and 5000 Series, order 016-0153-00 ..... $7.00
For 7000 Series, can also be used with Types 601, 602 and 528, order 016-0154-00 ..... $7.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Viewing Accessories

CATHODE-RAY TUBE LIGHT FILTERS

INSTRUMENT*	COLOR	PART NUMBER	PRICE
Type 310A, 317, 360	Smoke-gray†	378-0550-00	$1.35
	Green	378-0551-00	1.35
	Blue	378-0552-00	1.35
	Amber	378-0553-00	1.35
Type 321A	Smoke-gray†	378-0547-00	$1.15
	Green	378-0554-00	1.15
	Blue	378-0555-00	1.15
	Amber	378-0556-00	1.15
Type 323	Smoke-gray†	426-0403-00	$2.10
	Blue	426-0512-00	2.10
	Amber	426-0513-00	2.10
Type 422, 491	Smoke-gray†	378-0549-00	$ .90
	Green	378-0557-00	.90
	Blue	378-0558-00	.90
	Amber	378-0559-00	.90
Type 453, 454	Smoke-gray†	378-0576-00	$ .90
	Green	378-0576-03	.90
	Blue	378-0576-02	.90
	Amber	378-0576-01	.90
Type 502A, 503, 504, 507, 515A, 516, 530-, 540-, 550-Series, 565, 575, 580-Series	Smoke-gray†	378-0567-00	$1.60
	Green	378-0568-00	1.60
	Blue	378-0569-00	1.60
	Amber	378-0570-00	1.60
Type 529, 561B, 567, 568	Smoke-gray†	378-0560-00	$1.35
	Green	378-0561-00	1.35
	Blue	378-0562-00	1.35
	Amber	378-0563-00	1.35
Type 576	Blue†	378-0616-00	$1.60
Type 602	Smoke-gray†	378-0586-00	$1.00
	Amber	378-0595-00	4.10
Type 647A	Smoke-gray†	378-0548-00	$1.15
	Green	378-0564-00	1.15
	Blue	378-0565-00	1.15
	Amber	378-0566-00	1.15
Type 5000-Series	Blue†	378-0626-00	$1.60
Type 7000-Series	Blue†	378-0625-00	$1.60

*For both cabinet and rackmount instruments.

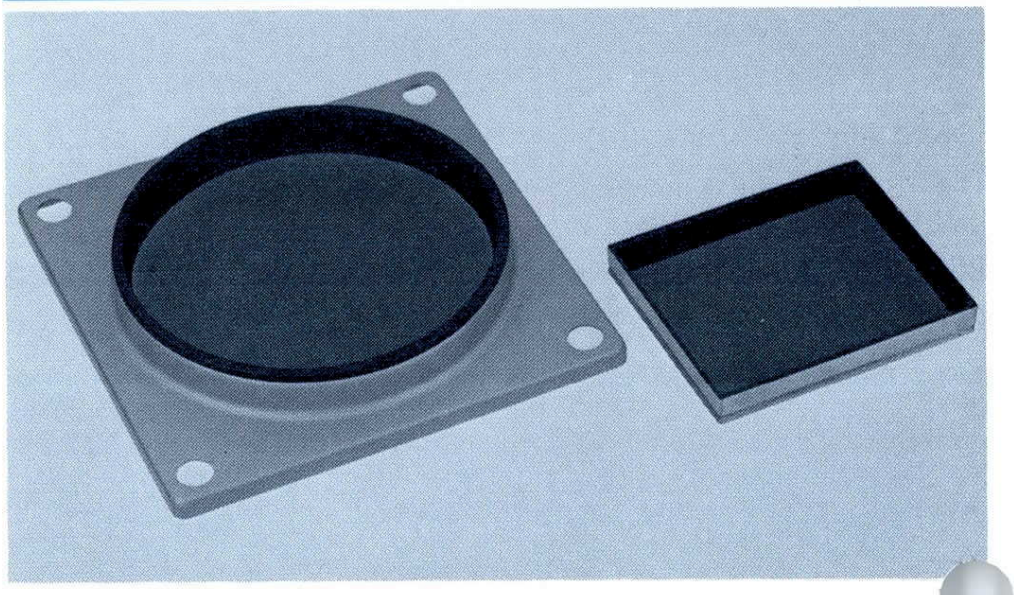
†Standard filter supplied with instrument.

UNSCRIBED GRATICULES

INSTRUMENT*	PART NUMBER	PRICE
310A, 317, 360	386-0395-00	$1.50
551, 575	331-0093-00	$2.00
502A, 503, 504, 515A, 516,	331-0105-00	$2.00
549	386-0451-00	$2.20
535A	386-0451-00 (adjustable)	$2.20
	331-0093-00 (not adjustable)	$2.00

*For both cabinet and rackmount instruments.

CRT MESH FILTERS



The mesh filter improves display contrast for oscilloscope viewing under high-ambient light conditions. The filter is a direct replacement for the existing graticule cover on most Tektronix instruments, or, in the case of the new portable oscilloscopes, snaps in the CRT opening on the front panel.

A fine metal screen with a matte black surface is utilized to reduce light reflections. Although light transmission from the CRT is reduced to approximately 28%, the high attenuation of external reflections allows viewing low-intensity displays in room light or other bright surroundings.

The mesh filter also serves as an RFI filter. Installed on the instrument, the metal frame of the filter is grounded, providing effective filtering of the RFI spectrum.

INSTRUMENT*	PART NUMBER	PRICE
Type 321A	378-0577-00	$13.00
Type 422, 491	378-0571-00	$13.00
Type 453, 454	378-0623-00	$13.00
Type 502A, 503, 504, 515A, 516, 530-, 540-, 550-, and 580-Series, 565	378-0572-00	$16.00
Type 529, 561B, 564B, 567, 568	378-0575-00	$16.00
Type 647A	378-0574-00	$16.00
Type 7000-Series	378-0603-00	$16.00

*For both cabinet and rackmount instruments.

U.S. Sales Prices FOB Beaverton, Oregon

Please refer to Terms and Shipment, General Information page.

Limited-Demand Instruments

The instruments described on this page are in limited demand, but represent a desirable choice in a few specialized cases. As such, they are available for you who have a need for them. Consult your Tektronix Field Engineer for information on other instruments in the Tektronix product line that generally give greater value in application areas presently filled by these instruments.

TYPE 507 OSCILLOSCOPE

The Tektronix Type 507 is a specialized oscilloscope, designed primarily for high-voltage surge testing of power transformers, high-voltage insulators, lightning arrestors, etc. Careful design of circuitry grounding points ensures minimum sensitivity to extraneous disturbances caused by large voltage transients often introduced into the grounding system.

TYPE 507 OSCILLOSCOPE **$3600**

TYPES B, G, AND H PLUG-IN AMPLIFIERS

The Type 1A6 described on page 132 and the Type 1A2 described on page 126 are recommended as replacements for the Types B, G, and H vertical Plug-In Amplifiers for Type 530-, 540-, 550-, and (with Type 81A adapter), 580-Series Oscilloscopes.

The Types B, G, and H Amplifiers are each DC coupled from two front panel inputs (1 megohm paralleled by approx 47 pF). Deflection factors and bandwidths are: Type B, 5 mV/cm to 20 V/cm within 3%, DC to 20 MHz*; Type G Differential Unit (100:1 CMRR), 50 mV/cm to 20 V/cm within 3%, DC to 20 MHz*; Type H, 5 mV/cm to 20 V/cm within 3%, DC to 15 MHz*, all bandwidths are specified with Type 540-Series Oscilloscope.

TYPE B PLUG-IN UNIT . . . . . **$ 195**
TYPE G PLUG-IN UNIT . . . . . **$ 235**
TYPE H PLUG-IN UNIT . . . . . **$ 230**

TYPE CA PLUG-IN UNIT

The Type 1A2 Plug-In Unit, described on page 126, is recommended as a replacement for Type CA.

The Tektronix Type CA Plug-In Unit contains two identical input channels. Either channel can be operated separately. The two channels can be electronically switched, either at a chopped rate of about 100 kHz, or triggered by the oscilloscope sweep. In addition, both channels can be combined at the output, adding or subtracting according to the settings of the polarity switches. Bandwidth is DC to 24 MHz when used with current-production Type 540-Series, Type 556, and (with Type 81A Adapter) 580- Series Oscilloscopes.

TYPE CA PLUG-IN UNIT . . . . . **$ 325**

TYPE K PLUG-IN UNIT

The Type L Plug-In Unit described on page 129 or the Type 1A2 Plug-In Unit described on page 130 are recommended as alternatives to the Type K Unit.

The Type K is a low-price, single channel plug-in for use with Type 530-, 540-, 550-, or (with Type 81A Adapter) 580-Series oscilloscope mainframes. Bandwidth is DC to 30 MHz maximum depending on mainframe bandwidth. Risetime is 12 ns max. deflection factor is 50 mV/cm.

TYPE K PLUG-IN UNIT . . . . . **$ 180**

*Bandwidths are derated with Types 530-, 550-, and 580-Series Oscilloscopes.

TYPE M PLUG-IN UNIT

The Type 1A4 Plug-In Unit, described on page 127, is recommended as a replacement for the Type M Unit.

The Type M Unit provides four-trace displays in Type 530-, 540-, 550- and (with Type 81A Adapter) 580-Series Oscilloscopes. The four input channels are identical. Each has separate controls for coupling, attenuating, inverting and positioning the signal. Chopped (successive 1-μs, approx, segments displayed) or alternate electronic switching can be used for multi-channel displays. Bandwidth is DC to 20 MHz with current production Type 540-Series, 556, and (with 81A adapter), the 585A Oscilloscopes.

TYPE M PLUG-IN UNIT . . . . . **$ 625**

TYPE 1L30 SPECTRUM ANALYZER PLUG-IN UNIT

The Type 1L20 and 1L40 cover, with considerable overlap, the range from 10 MHz to 40 GHz (see page 218).

The Type 1L20 or the Type 1L40 Spectrum Analyzer Plug-In Units are recommended as alternatives to the Type 1L30 except for applications best covered by the center frequency range of the Type 1L30 (925 MHz to 10.5 GHz).

The Type 1L30 is identical in operation and specifications to the Type 1L20 except for the center frequency range mentioned.

TYPE 1L30 SPECTRUM ANALYZER UNIT **$1950**

TYPE 133 PLUG-IN UNIT POWER SUPPLY

The Type 127, described on page 145 or the Type 132, described on page 147 is recommended as a replacement for the Type 133.

The Type 133 provides power to an internal, transistorized amplifier and any Tektronix Letter-Series or 1-Series Plug-In Unit. Connectors on the front-panel enable the output to be fed directly into an oscilloscope or used for other applications.

The bandwidth is from DC to 100 kHz with a gain of 10 in the single-ended amplifier. The output is: 5 V (high-impedance load), 1.5 A (short circuit), source impedance 2 Ω. The output DC operating level adjusts to ground potential. A monitor jack, either output polarity, and an alternate (dual trace) mode of operation are some of the features provided.

TYPE 133 POWER SUPPLY, without plug-in units . . **$ 525**

TYPE 531A, 533A, and 543B OSCILLOSCOPES

The Type 544 described on page 102, is recommended as a replacement for the Type 531A, 533A, and 543B.

The Type 531A, 533A, and 543B all have 6 x 10 cm graticules and will accept all Tektronix Letter-Series and 1-Series Plug-In Units. Time bases are calibrated from 0.1 μs/cm to 5 s/cm. The Type 531A has a X5 sweep magnifier and 15-MHz bandwidth. The Type 533A has a X100 sweep magnifier, single sweep, and 15-MHz bandwidth. The Type 543B and RM543B (rackmount) have a X100 sweep magnifier, single sweep, and 33-MHz bandwidth.

TYPE 531A OSCILLOSCOPE, without plug-in units . **$1150**
TYPE 533A OSCILLOSCOPE, without plug-in units . **$1275**
TYPE 543B OSCILLOSCOPE, without plug-in units . **$1450**
TYPE RM543B OSCILLOSCOPE, without plug-in units **$1550**

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to Terms and Shipment, General Information page.

Limited-Demand Instruments

The instruments described on this page are in limited demand, but represent a desirable choice in a few specialized cases. As such, they are available for you who have a need for them. Consult your Tektronix Field Engineer for information on other instruments in the Tektronix product line that generally give greater value in application areas presently filled by these instruments.

TYPE 536 (X-Y) OSCILLOSCOPE TYPE T TIME-BASE UNIT

The Type 561B with any matched pair of 560-Series vertical plug-ins is recommended as a replacement for the Type 536 in X-Y applications (see page 62).

The Type 536 is used primarily for X-Y displays, its accuracy obtained with the use of an Amplifier Phasing control. Relative phase shift is less than 1° to 15 MHz with two Type K Units at 50 mV/div. Front-panel control adjusts amplifier phasing to 30 MHz, with signals not overdriving Type K units. Using identical wideband Plug-In Units, horizontal and vertical deflection systems are almost identical. It is also a 11-MHz general purpose oscilloscope when used with the Type T Time-Base Generator.

TYPE 536 OSCILLOSCOPE, without plug-in units . . **$1325**
TYPE T TIME-BASE GENERATOR . . . . . **$ 300**

TYPE 581A OSCILLOSCOPE TYPE 86 AMPLIFIER

The Type 585A on page 119 with a Type 82 Dual-Trace Plug-In Unit (DC-80 MHz) is recommended as a replacement for the Types 581A and 86.

The Type 581A Oscilloscope is a general-purpose laboratory instrument featuring bandwidth to 80 MHz (at 3-dB down) when used with the Type 82 or Type 86 Plug-In Unit. Tunnel-diode triggering to 150 MHz and HF Sync to 250 MHz makes the instrument useful beyond the specified bandwidth. The horizontal consists of a calibrated (3%) time base from 50 ns/cm to 2 s/cm, a X5 magnifier, single sweep, and external horizontal input.

The Type 86 Single Trace Plug-In Unit provides fast-rise capability, a calibrated deflection-factor range of 100 mV/cm to 50 V/cm (within 3%) and a built-in X10 amplifier which extends the deflection-factor range to 10 mV/cm at 75 MHz. Input RC is 1 megohm paralleled by approx 15 pF. A P6008 Probe is supplied with the Type 86.

TYPE 581A OSCILLOSCOPE, without plug-in units . **$1700**
TYPE 86 PLUG-IN UNIT . . . . . **$ 425**

TYPE 567/6R1A/262 DIGITAL MEASUREMENT SYSTEM

The Type 568/230/241 Digital Instruments, described on pages 231, 239, and 246 respectively, are recommended as replacement units for the Type 567/6R1A/262 Units.

The Type 567/6R1A Digital Readout Oscilloscope provides digital readout of the waveform displayed on the cathode-ray tube when used with suitable vertical and horizontal plug-in units. Digital readout provides greater accuracy, speed, and convenience of measurement over conventional CRT displays.

The Type 262 Programmer makes it possible to remotely control the measurement and readout capabilities of the Type 6R1A Digital Unit. Any set of up to 8 different preselected time or voltage measurements can be made with each Type 262 used.

TYPE 567 OSCILLOSCOPE, without plug-in units . . **$ 850**
TYPE RM567 OSCILLOSCOPE, without plug-in units **$ 950**
TYPE 6R1A DIGITAL UNIT **$3100**
TYPE 262 PROGRAMMER **$1775**

TYPE R293 PROGRAMMABLE PULSE GENERATOR and POWER SUPPLY

The Type R293 is a combination pulse generator and power supply which may be used in testing time and charge parameters of semiconductor devices, testing switching and propagation times of micro-logic circuits, or applications which require fast-rise and fast-fall pulses.

As an example, programmable parameters can be remotely controlled (automatic sequence optional) with the Type 262 Programmer. The Type 567 Readout Oscilloscope and Type 6R1A Digital Unit may be used to display the results of each measurement and indicate whether results are within, above, or below predetermined limits. The pulse amplitude may be varied from 6 V to 12 V with a pulse width from 2 ns to 250 ns (into 50 Ω) and a pulse repetition rate from $<$10 kHz to $\approx$100 kHz.

TYPE R293 PROGRAMMABLE PULSE GENERATOR AND POWER SUPPLY **$1150**

TYPE 184 TIME-MARK GENERATOR

The Type 2901, described on page 366, is recommended as a replacement for the Type 184 Time-Mark Generator.

The Type 184 provides 16 marker intervals, 5 sinewave frequencies, and 7 trigger-pulse intervals. More than one marker interval (up to two decades apart) can be obtained at one time by pushing the desired buttons simultaneously. Triggers are time-coincident with the corresponding markers.

The Type 184 is transistorized (plus 6 nuvistors) and is frequency controlled by a temperature-stabilized 10-MHz crystal oscillator.

TYPE 184 TIME-MARK GENERATOR . . . . . **$ 760**

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Please refer to Terms and Shipment, General Information page.

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